15 Sheets—Sheet 1.

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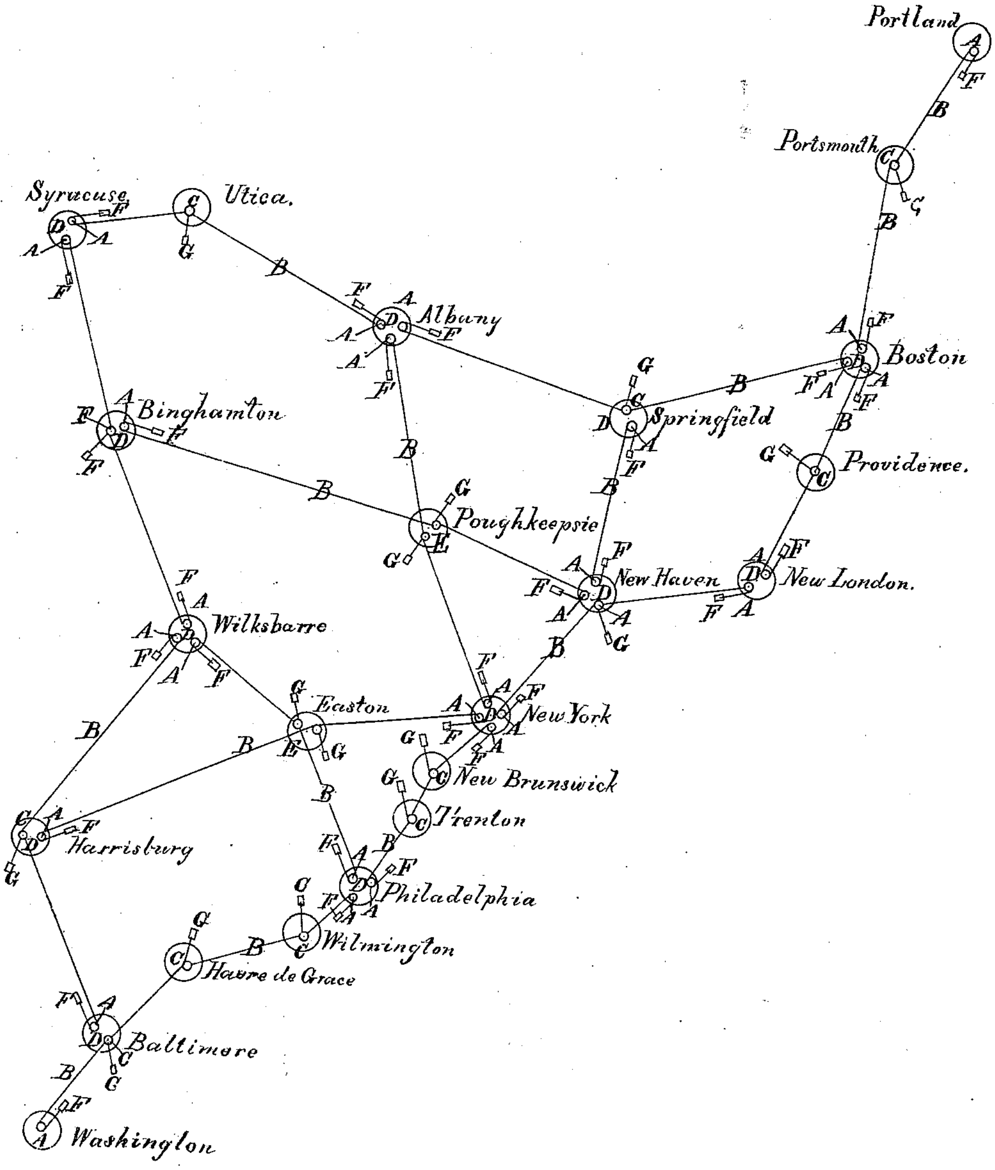
ELECTRIC TELEGRAPH.

No. 180,099. Patented July 25, 1876.



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His Attys.

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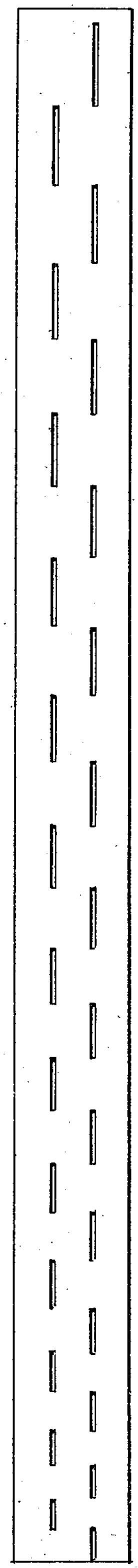

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15 Sheets—Sheet 3.

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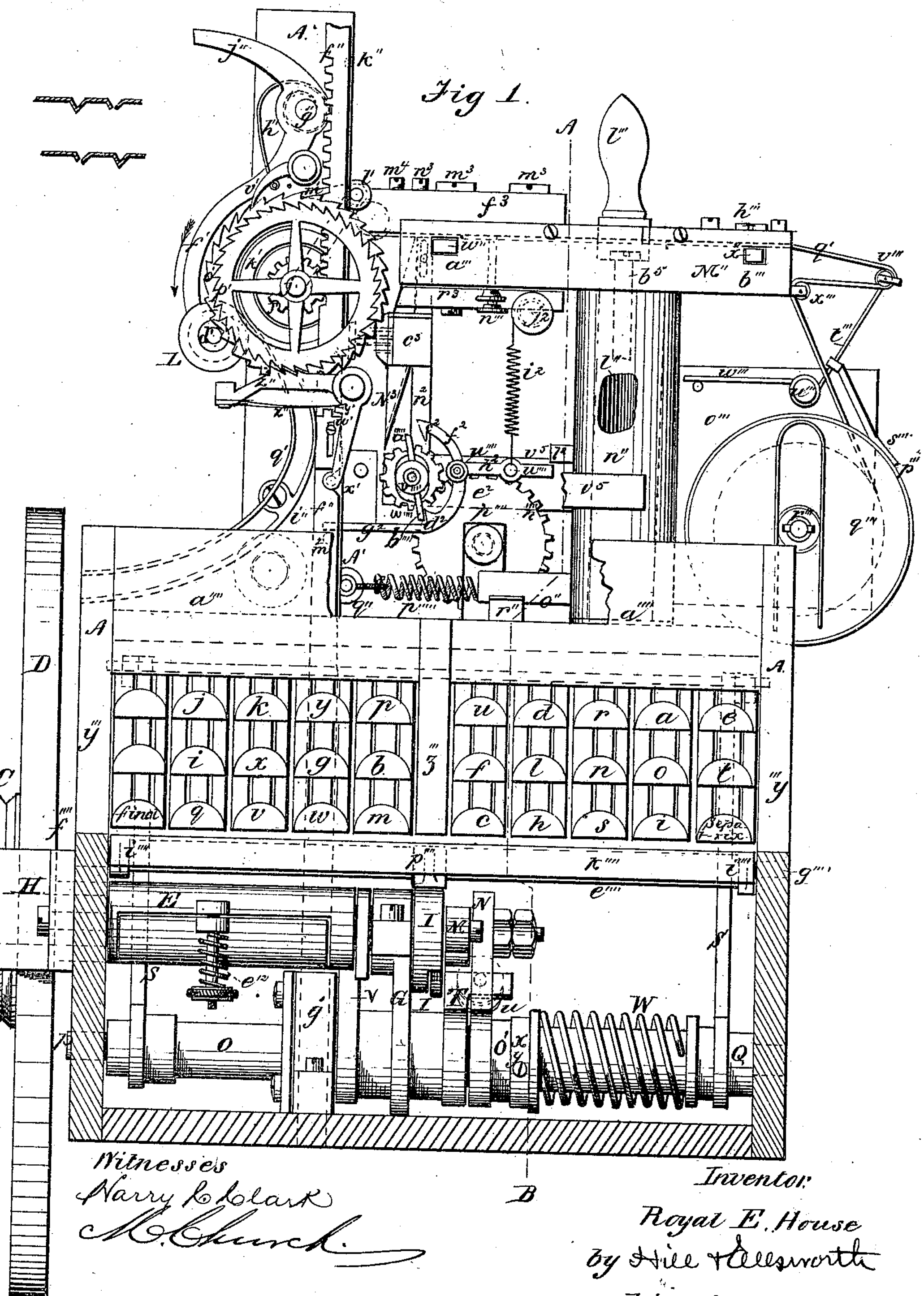

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15 Sheets—Sheet 4.

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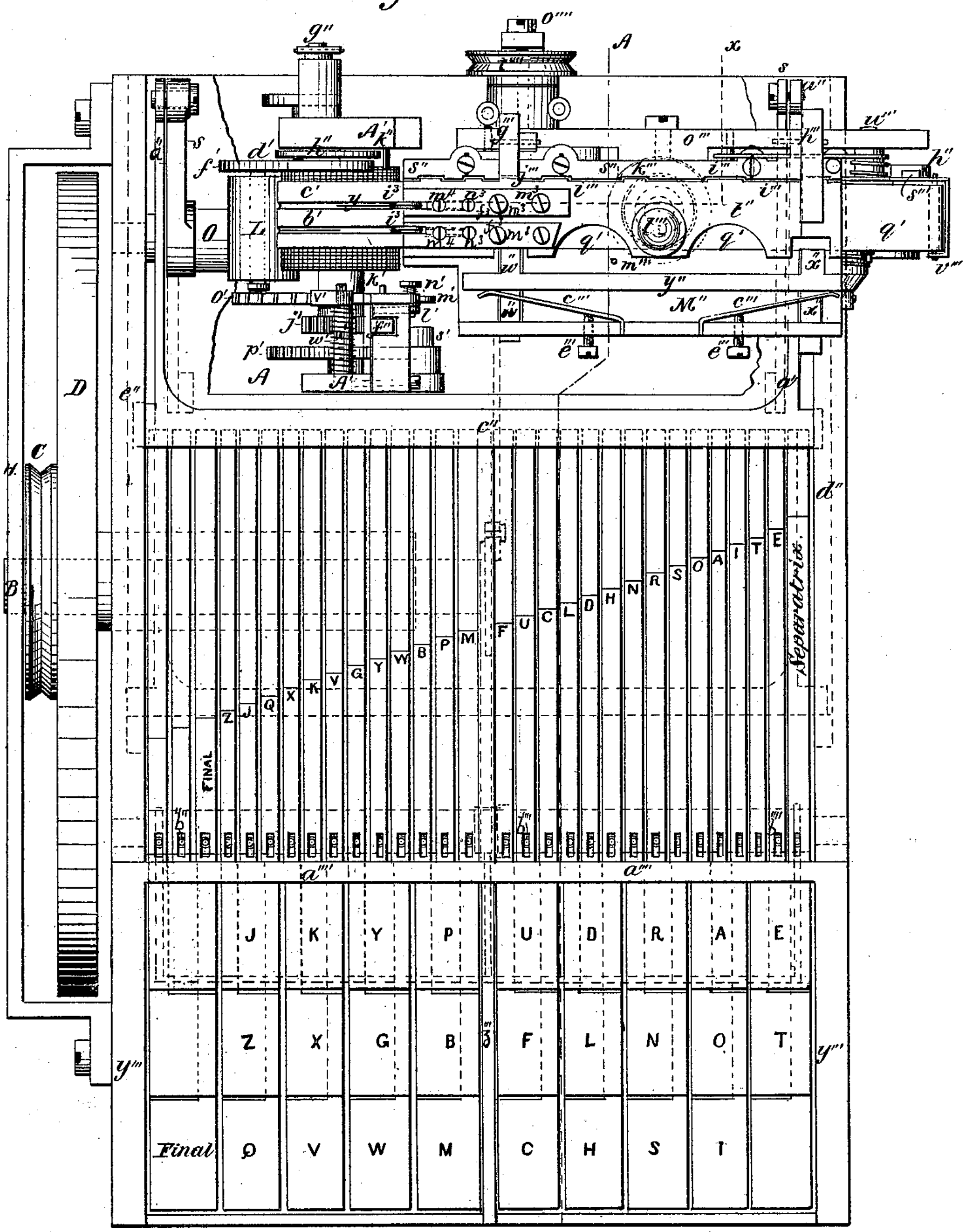
Fig 2.



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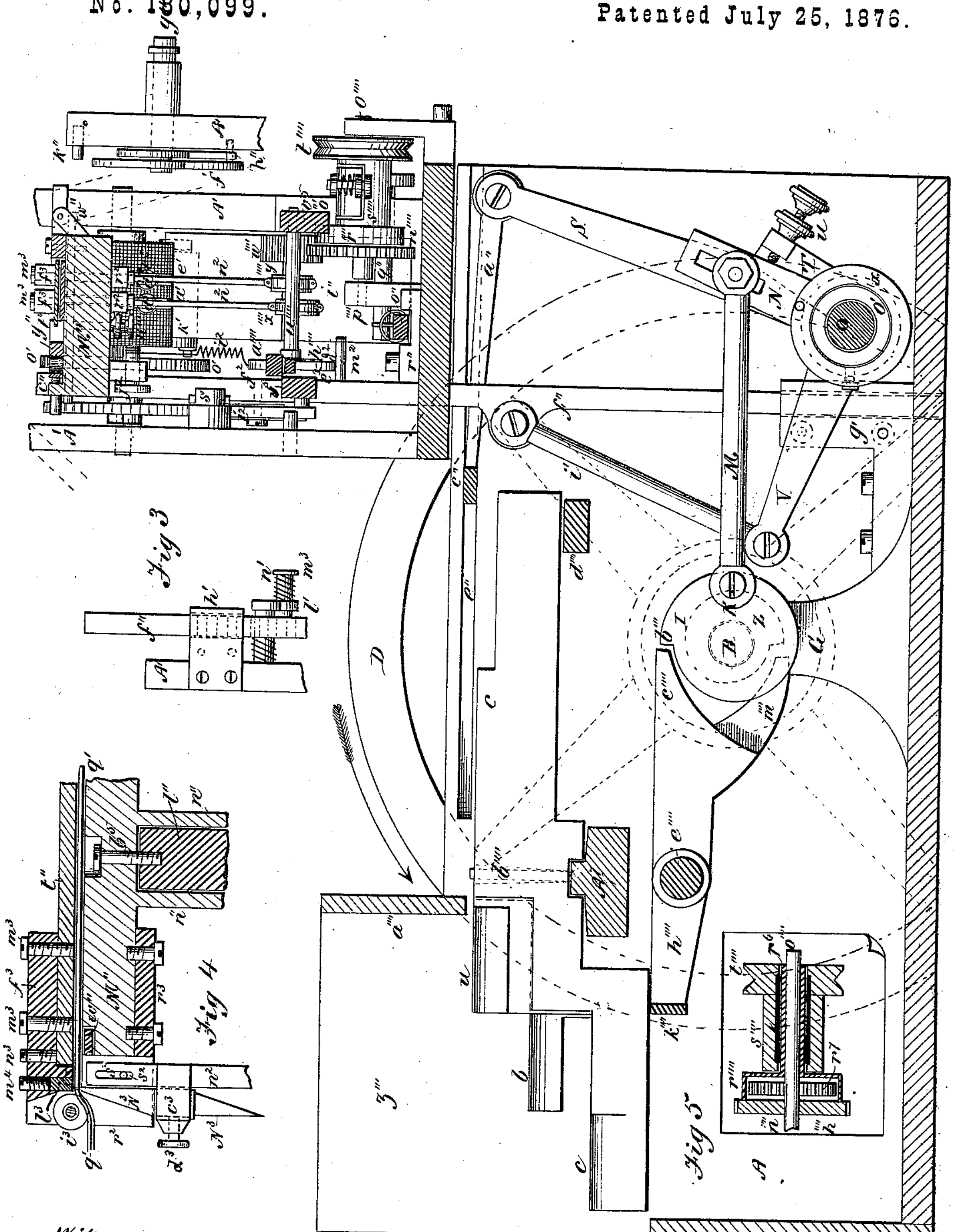

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15 Sheets—Sheet 6.

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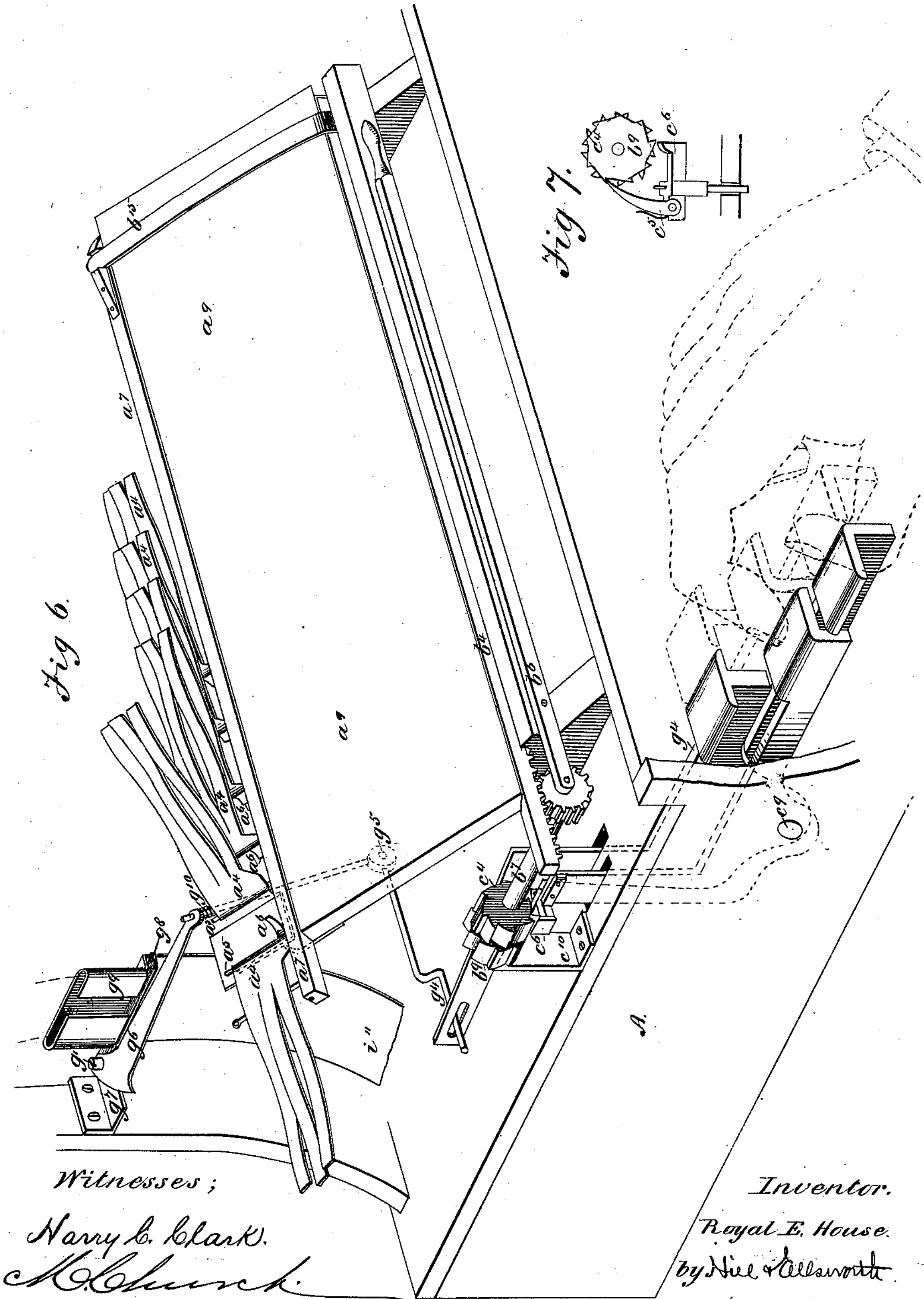

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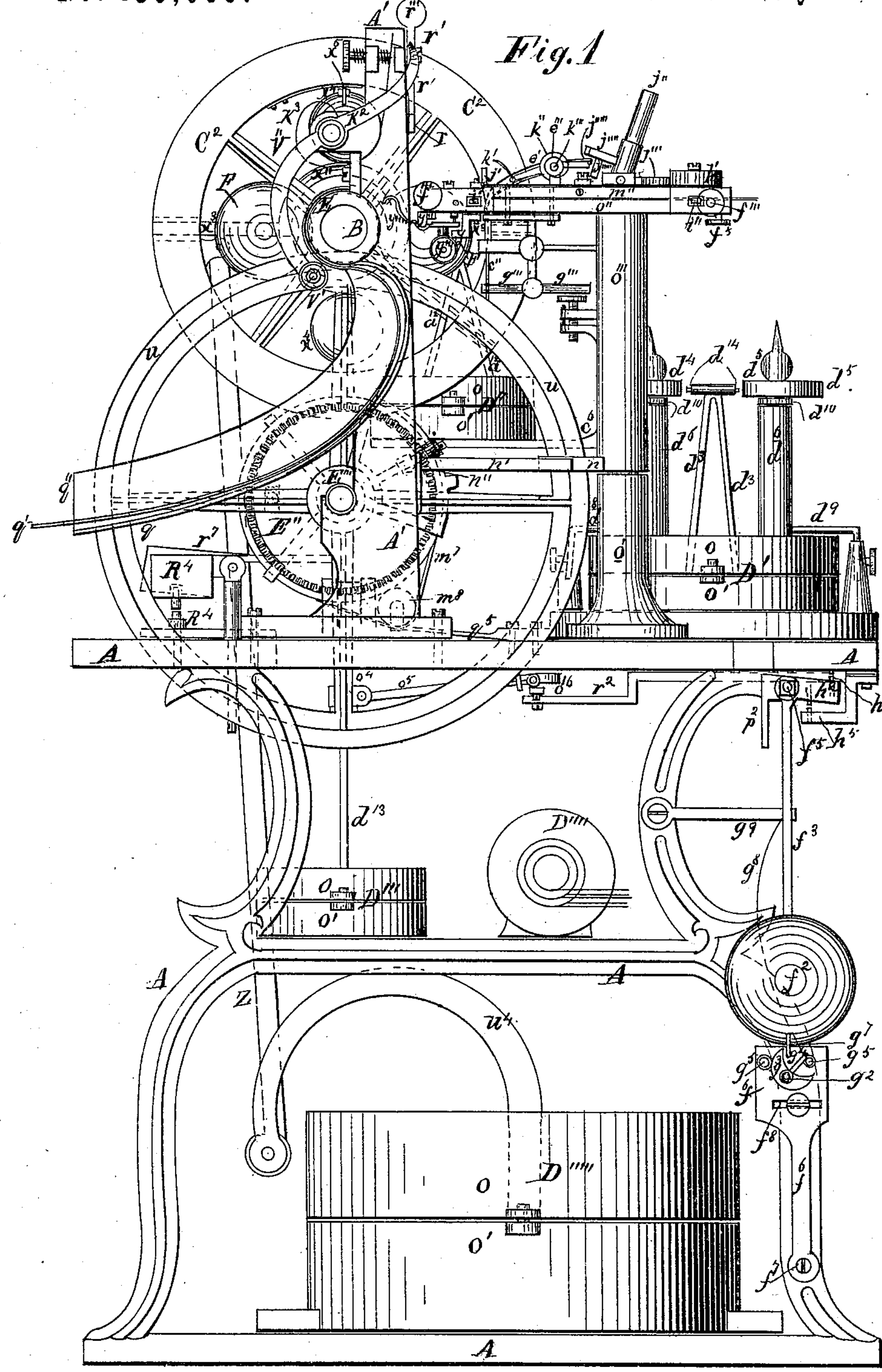
Fig. 1



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15 Sheets—Sheet 8.

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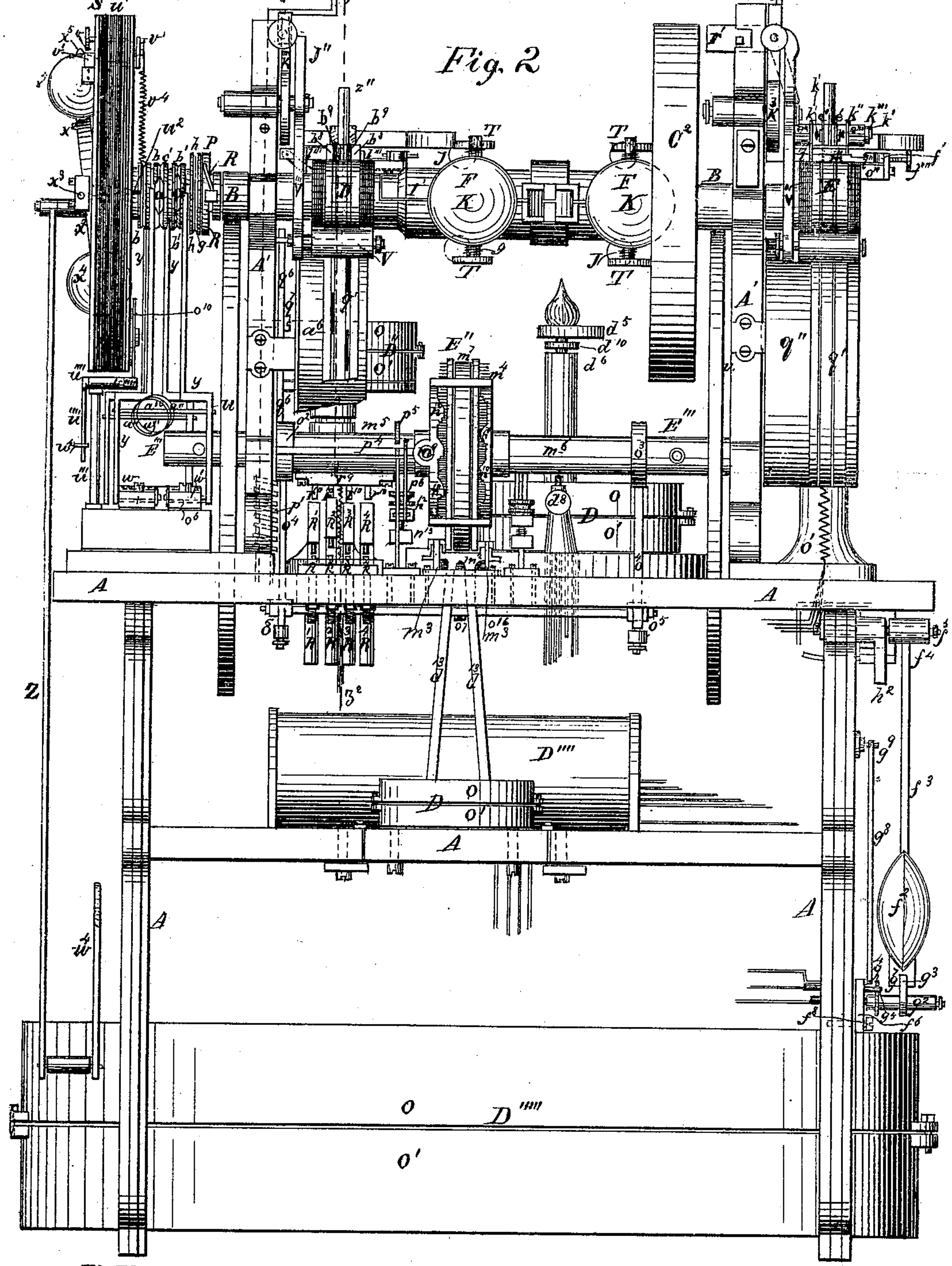
Fig. 2



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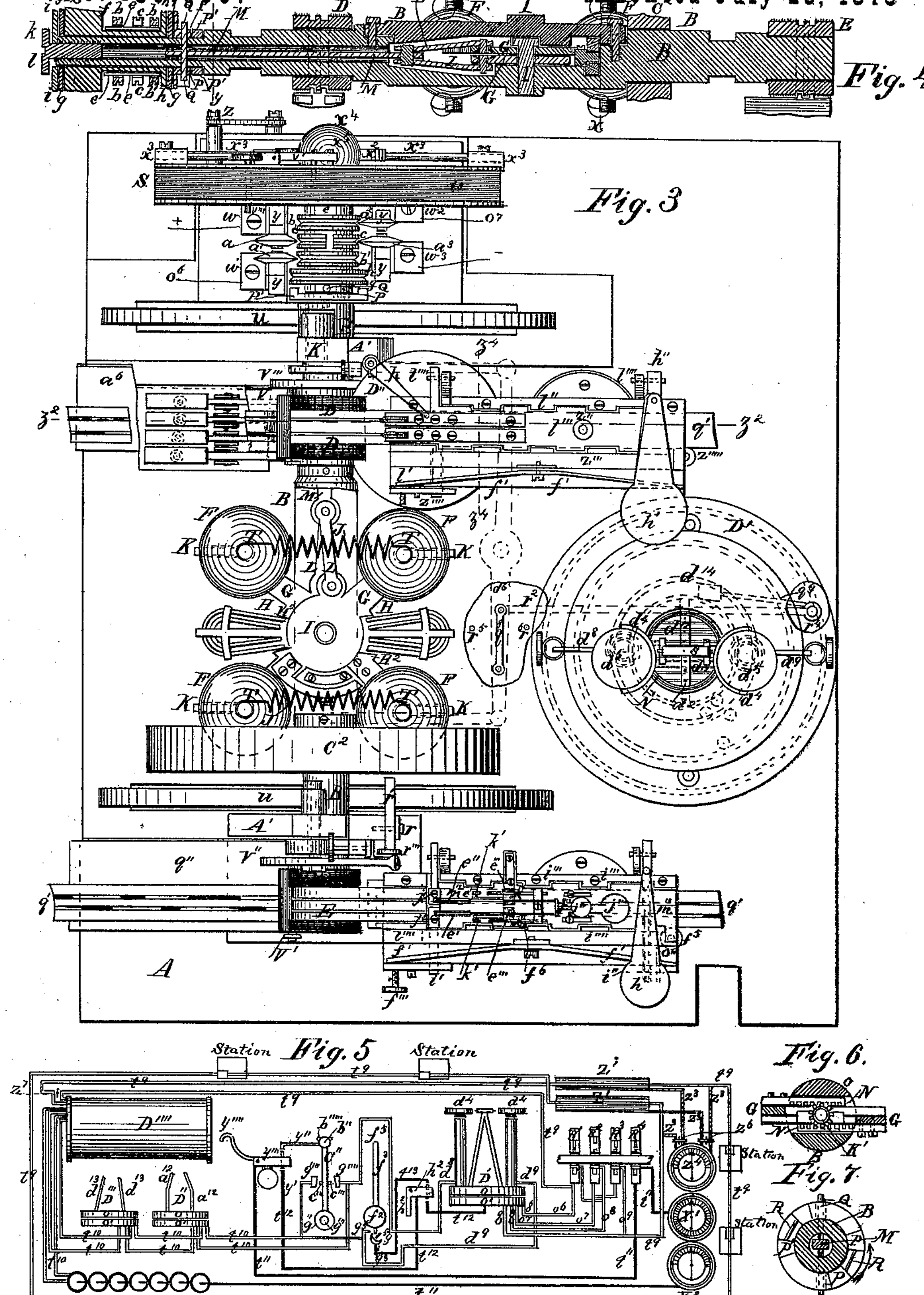

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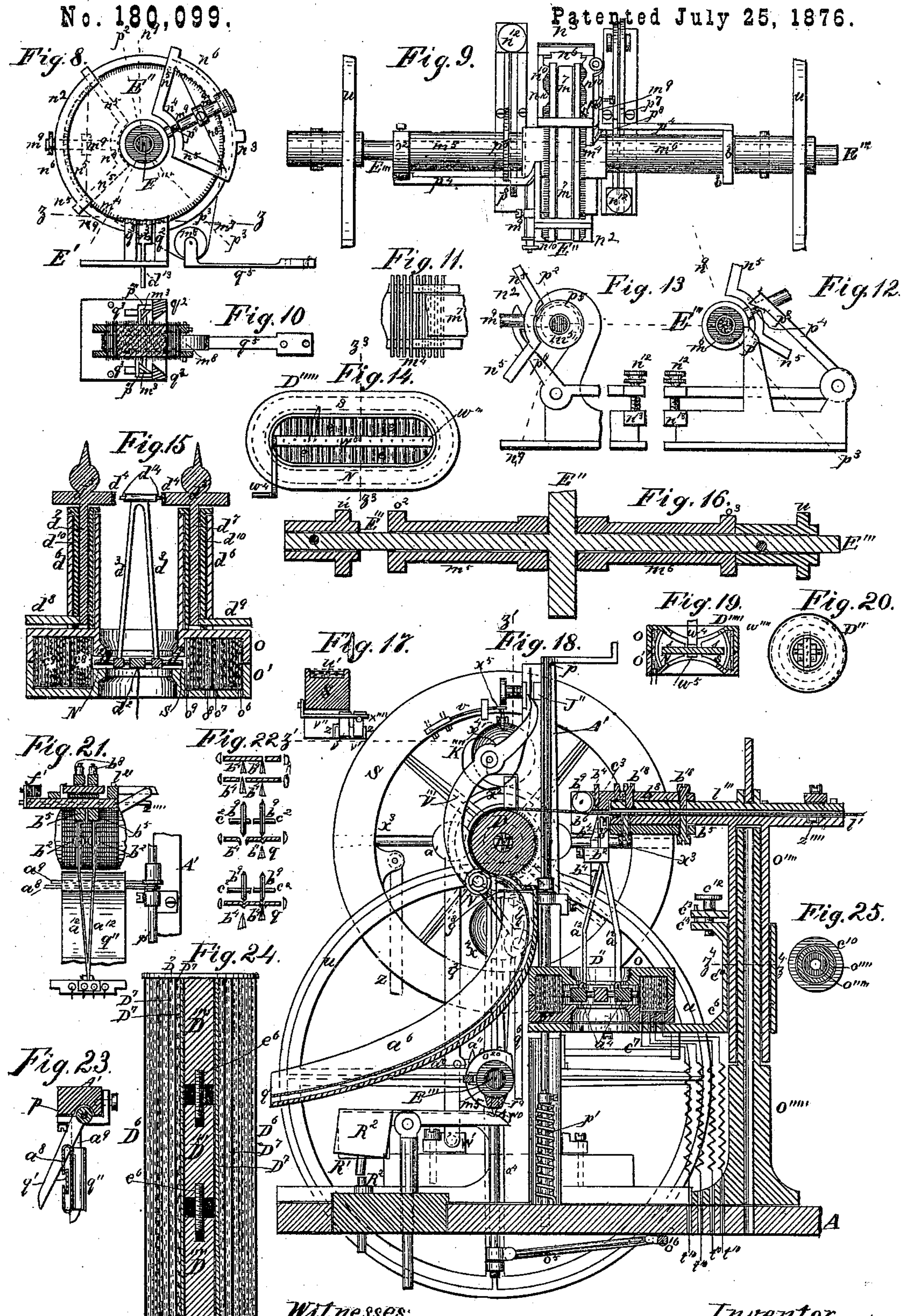

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Fig 26.

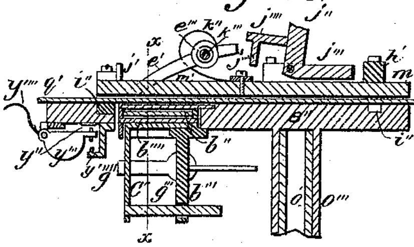


Fig 27.

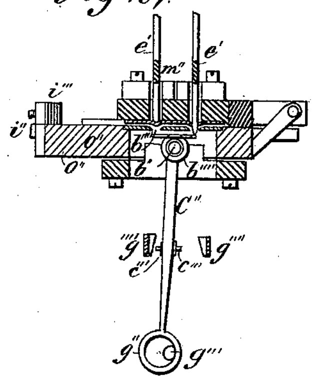


Fig 28.

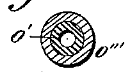


Fig 29.

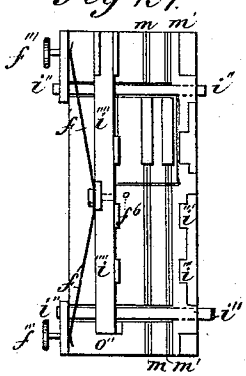
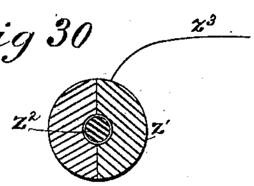


Fig 30



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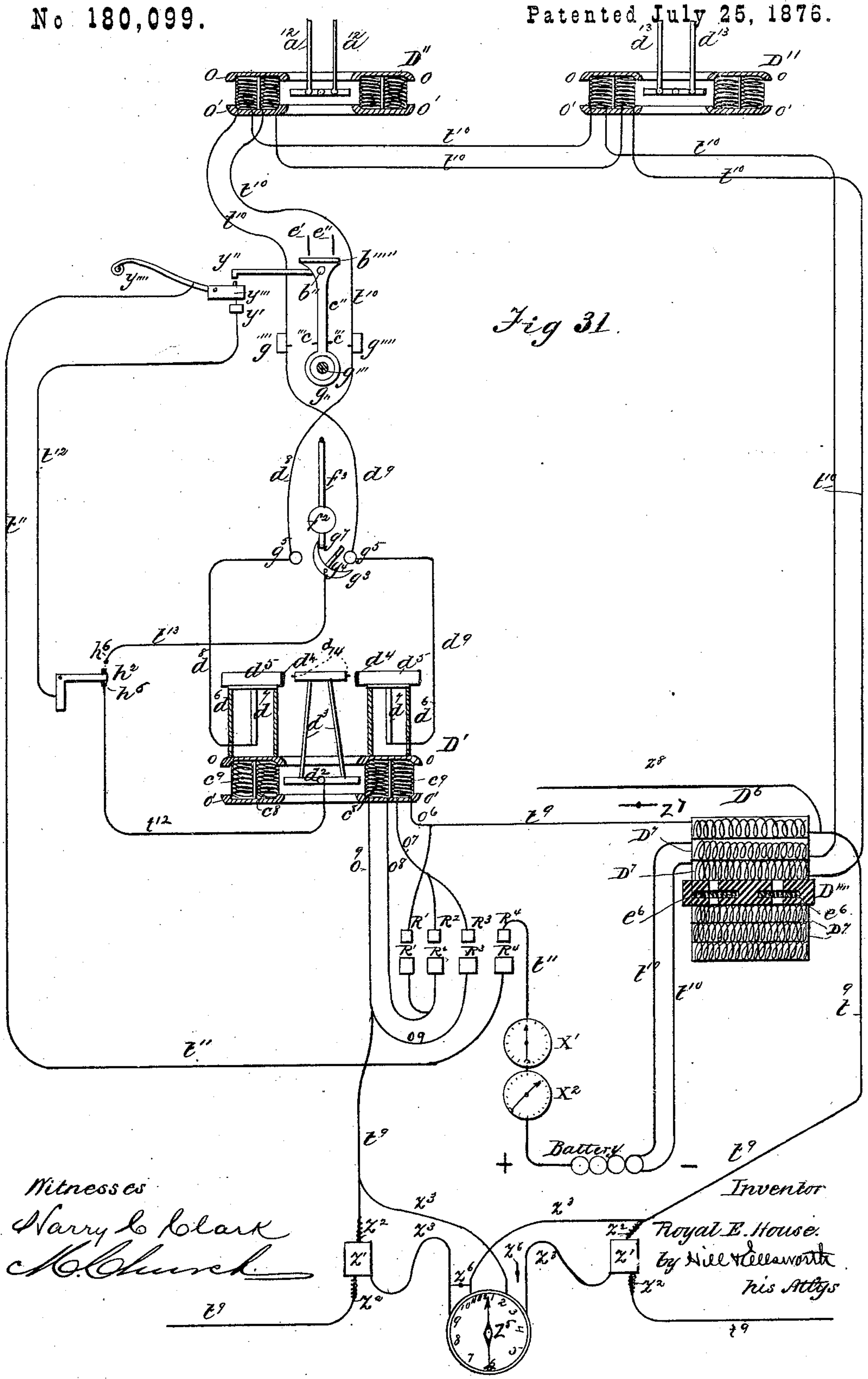

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15 Sheets—Sheet 13.

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ELECTRIC TELEGRAPH.

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Fig. 1

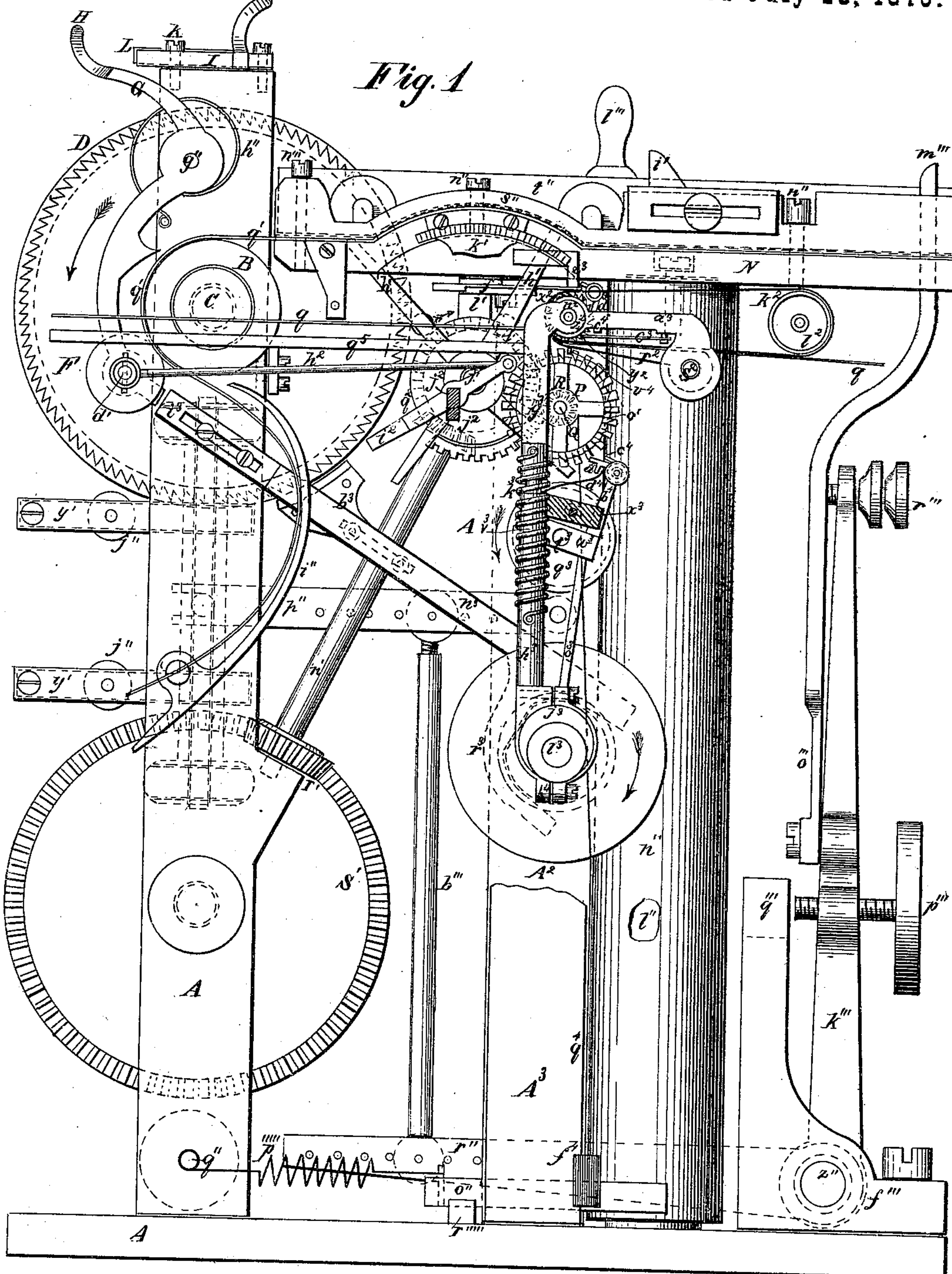

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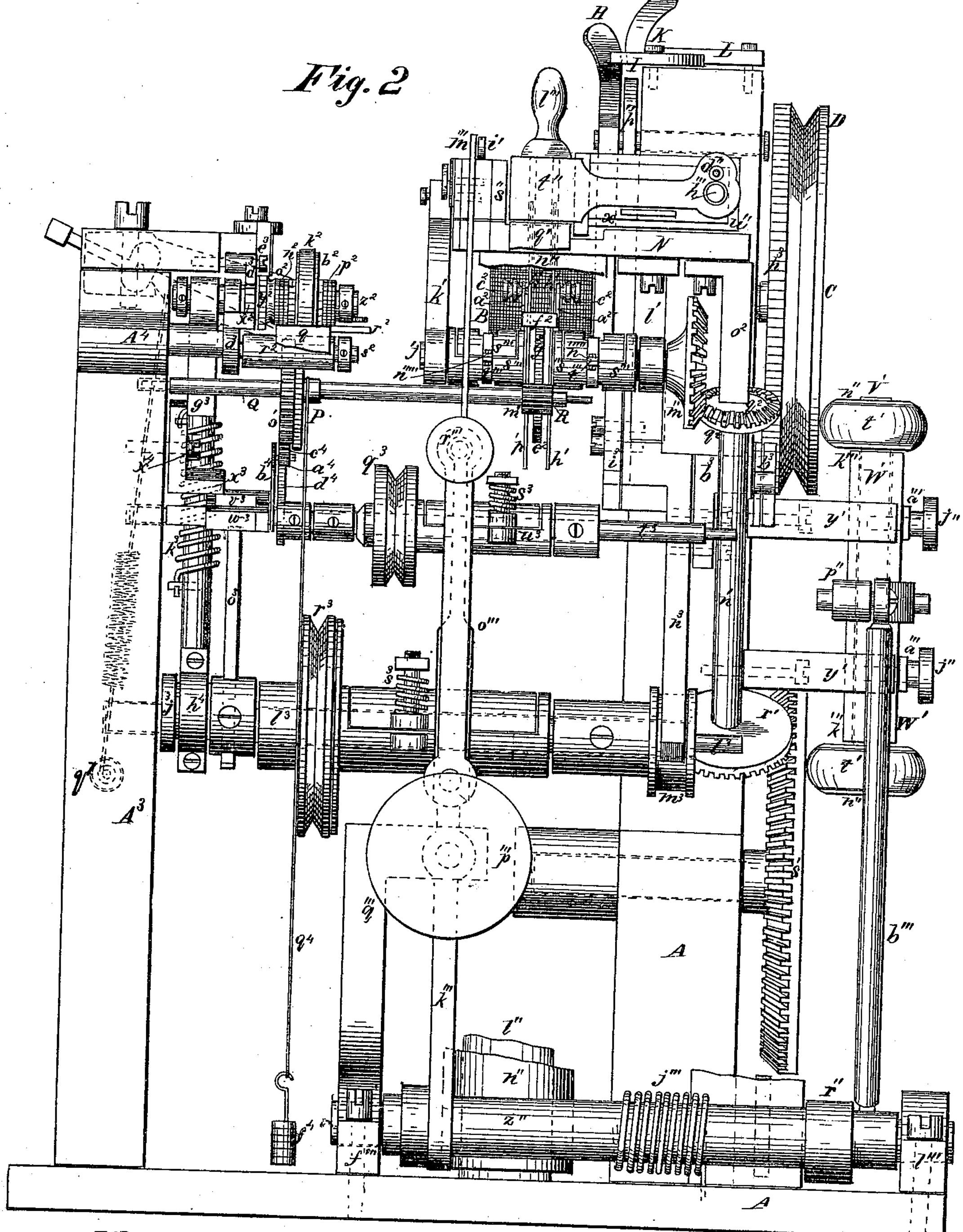
Fig. 2



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15 Sheets—Sheet 15.

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Fig. 3

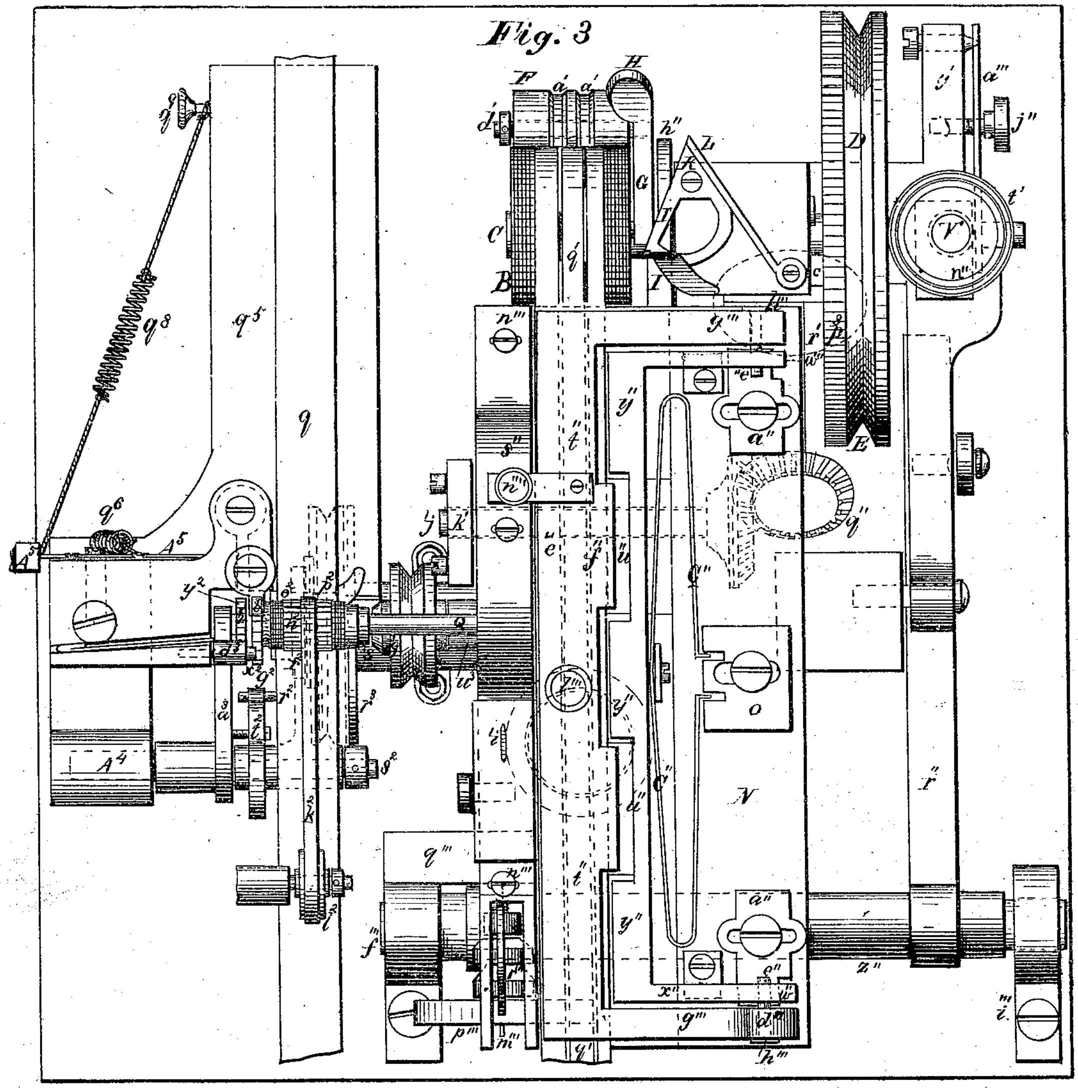


Fig. 4.

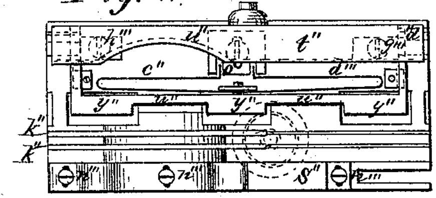
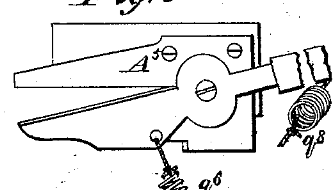


Fig. 5



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UNITED STATES PATENT OFFICE.

ROYAL E. HOUSE, OF BINGHAMTON, NEW YORK.

IMPROVEMENT IN ELECTRIC TELEGRAPHS.

Specification forming part of Letters Patent No. **180,099**, dated July 25, 1876; application filed March 19, 1874.

To all whom it may concern:

Be it known that I, ROYAL E. HOUSE, of Binghamton, in the county of Broome and State of New York, have invented a new and useful Automatic Reproducing Record Telegraph for Postal Service; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Sheet 1 shows a diagram of the telegraph lines and routes illustrating my improved system of telegraphing, and Sheet 2 shows a plan view of a record or message fillet.

The group of figures upon Sheets 3 to 6, inclusive, illustrate the mechanism for producing the original record-fillet, as follows, to wit:

Figure 1, Sheet 3, is a front elevation of the instrument, with part of the frame removed to show the interior mechanism under the keys. Fig. 2, Sheet 4, is a top-plan view, with parts of the frame broken away to show the mechanism for feeding the fillet of paper and making the record. Fig. 3, Sheet 5, is a longitudinal section of the instrument, taken in the plane of the line A B, Fig. 2, the top being cut off to the right and left, as shown by dotted lines. Fig. 4, Sheet 5, is a vertical longitudinal section of the guide-bed and its support. Fig. 5, Sheet 5, is a sectional view of the shaft, friction-sleeve, and devices connected therewith, by which the eccentric shaft is operated from the prime mover of the instrument. Fig. 6, Sheet 6, is a perspective view of the message-rack. Fig. 7, Sheet 6, is a detached view of the ratchets and pawls employed to operate the message-rack.

The group of figures upon Sheets 7 to 12, inclusive, illustrate the transmitting and reproducing mechanisms and their connections, as follows:

Fig. 1, Sheet 7, is an end elevation of this mechanism. Fig. 2, Sheet 8, is a front elevation. Fig. 3, Sheet 9, is a top-plan view. Fig. 4, Sheet 9, is a longitudinal section of the driving-shaft and its attachments. Fig. 5, Sheet 9, is a diagram showing a telegraph-line, its ground-plates, and five intermediate stations, one of which is provided with all the electric connections used at each station. Fig. 6, Sheet 9, is a transverse section of the driving-shaft, taken in the line x x, Fig. 4. Fig. 7, Sheet 9, is a similar section of the shaft, taken in the line y y, Fig. 4. Fig. 8, Sheet 10, is a side elevation of the registering-wheel, showing the calling-in frame, together with the tension and setting devices for the pins of the wheel. Fig. 9, Sheet 10, is a top-plan view of the registering-wheel and its devices, mounted upon the counter-shaft. Fig. 10, Sheet 10, is a horizontal section of the registering-wheel, taken in the line z z, Fig. 8. Fig. 11, Sheet 10, is a detached section of the registering-wheel, with pins aligned. Figs. 12 and 13, Sheet 10, are elevations, respectively, of the devices for unlocking the throwing-out and calling-in frames from the pins of the registering-wheel. Fig. 14, Sheet 10, is a top-plan view of the magnet from which the main shaft of the apparatus is driven. Fig. 15, Sheet 10, is a central vertical section of the receiving-magnet. Fig. 16, Sheet 10, is a longitudinal section of the counter-shaft and sleeves of the calling-in and throwing-out frames. Fig. 17, Sheet 10, is a section taken through the rim of the driving-wheel, in the plane of the line z^1 z^1, Fig. 18. Fig. 18, Sheet 10, is a vertical section of the apparatus through the line z^2 z^2, Fig. 2. Fig. 19, Sheet 10, is a transverse section of the driving-magnet through the line z^3 z^3, Fig. 14. Fig. 20, Sheet 10, is a top-plan view of the reproducing-magnet with the slitting-knives and their upright arms removed. Fig. 21, Sheet 10, is a transverse vertical section of the guide-bed for the reproducing-instrument, showing the slitting-knives in elevation. Fig. 22, Sheet 10, shows the several positions of the slitting-knives and embossing-rollers of the reproducing mechanism. Fig. 23, Sheet 10, is a top-plan view of the shears for cutting the fillet of paper, and a transverse section of the guide for directing the paper away from the reproducing devices. Fig. 24, Sheet 10, is a longitudinal section of the induction-coil. Fig. 25, Sheet 10, is a transverse section of a guide-bed, taken through the line z^4 z^4, Fig. 18. Fig. 26, Sheet 11, is a longitudinal section of the transmitting guide-bed. Fig. 27, Sheet 11, is a transverse section of the same. Fig. 28, Sheet 11, is a transverse section of the supports for such bed. Fig. 29, Sheet 11, is a top-plan view of the bed. Fig. 30, Sheet 11, is a transverse section of one of the lightning arresters; and Fig. 31, Sheet 12, is a diagram showing all the electric connections of the apparatus, together with all the parts of the latter necessary for tracing the course of the currents.

The group of figures upon Sheets 13 to 15, inclusive, illustrate the printing-mechanism as follows:

Fig. 1, Sheet 13, is a side elevation of the printing-instrument, partly in section. Fig. 2, Sheet 14, is an end view. Fig. 3, Sheet 15, is a top-plan view. Fig. 4, Sheet 15, is a plan view of the guide-bed detached from the instrument. Fig. 5, Sheet 15, is a detached view of the spring-shears by which the printed message is cut from the printing-fillet of paper.

The letters of reference are different for each group of figures, but similar letters in each group denote the same parts of that group.

It is found in practical telegraphy that, from various causes, messages can only be transmitted a comparatively short distance before they must be treated as new messages, and retelegraphed to succeeding stations.

Mr. George B. Prescott, electrician of the Western Union Telegraph Company, in an article published in the Journal of the Telegraph, under date of April 1, 1870, page 107, entitled "The Telegraph in Switzerland," says, in speaking of telegraphic communication in the United States, that "Messages, therefore, instead of being generally transmitted five hundred and one thousand miles by one manipulation, are repeated between the greater portion of the offices upon an average of every one hundred miles. In most cases this repetition is made by hand, and every such repetition costs as much as the original transmission." For this reason long telegraph routes are necessarily made up of a succession of short lines.

The automatic-telegraph system in use at the present time is based upon the transmission of messages by the Morse characters, and, therefore, in sending a message over several of these successive lines, it must also be prepared anew by the operator at the end of each line before it can be automatically transmitted. This occasions great delay, for, while the actual transmission over the wire is exceedingly rapid as compared with the Morse system, the time consumed by the operators after receiving a transmitted message, in preparing it over again to be automatically transmitted, is proportionally very great.

My invention, in addition to the general improvement of the telegraphic art, has for its object to overcome this difficulty, and automatically transmit a message over a succession of telegraph lines without the necessity for its repreparation at the end of each line, so that in sending a message it shall be automatically reproduced at the end of a line for automatic transmission over the next line, thereby saving all the time and labor now required to telegraph by the automatic system.

To this end my invention consists, first, in a system of harmonized mechanism constituting a complete electric telegraph, and composed of the following elements, to wit: first, an instrument by which the written messages received at a station for transmission are recorded in a fillet of paper to be used as the medium for automatically transmitting the message from one station to another; second, the batteries and insulated wires constituting the line or lines; third, a sending-instrument, adapted, in connection with the record-fillet, to automatically transmit to the receiving-station message-signals corresponding to the record-signs of the fillet; fourth, a receiving-instrument adapted to receive such electric signals, and thereby automatically produce at the receiving-station an exact facsimile of the original record-fillet at the sending-station; and, lastly, mechanism adapted to receive such reproduced record-fillet, and therefrom automatically produce a dispatch for delivery, printed in ordinary typographic characters.

In the second place my invention consists in adapting different and independent telegraph-lines, and the instruments used in connection therewith, to operate in harmony with each other, so that either an original record-fillet or a reproduced record-fillet of one line can be used equally well to automatically operate any other line.

In the third place my invention consists in the mode or process of automatically transmitting a dispatch over a succession of telegraph-lines by the following steps, to wit: first, producing at the sending-station, by proper mechanism independent of the line, a record of the dispatch to be transmitted; second, automatically transmitting message signals or impulses; third, automatically reproducing at the receiving-station of a line, by proper mechanism, a fac-simile of the record at the sending-station; fourth, using, by suitable mechanism at the proper receiving-stations, the successively-reproduced records to automatically transmit the message over each succeeding line until the final or delivery station is reached; and, fifth, using the reproduced record at the final station, by means of proper mechanism independent of the line, to automatically print the message in ordinary typographic characters for delivery.

For the purpose of illustrating my improved system of telegraphing I have shown, upon Sheet 1 of the accompanying drawings, a diagram of telegraph lines, routes, and stations, which, together with the following general explanation, will afford a comprehensive view of the whole system.

In furtherance of this purpose it is necessary to define a telegraph-line and a telegraph-route.

A telegraph-line comprises the wires, batteries, and instruments of two or more stations, which have such an electrical connection with each other that an electrical impulse given at any one station is felt at all the others, or throughout the entire length of the connected wires.

A telegraph-route is composed of two or more of such telegraph-lines united together at certain stations, but having no electrical connection with each other. The diagram shows several different telegraph lines and routes, which may be easily traced. For example, one line, with its way-stations, extends from Washington to Philadelphia; another from Philadelphia to New York; another from New York to New London; another from New London to Boston, and still another from Boston to Portland, the whole number constituting one telegraph-route.

The two end stations of a telegraph-line, which, in the diagram, are marked A, and which are connected by a wire, B, I designate as the "terminal stations," and all those marked C, intervening between the terminal stations, and through which the wires pass directly, I denominate the "way-offices" or "intermediate stations." The stations D, at which two or more lines are joined, I call the "junction-offices," and those stations E, at which two or more lines cross or intersect each other, I call the "intersection-offices." Certain offices may be junction-offices of two or more lines, and the way-offices of one or more lines—as, for example, the New Haven office shown on the diagram, which is the junction-office of the Springfield and New Haven line, the junction-office of the Binghamton and New Haven line, and the way-office of the New York and New London line. An office may also be the terminal of one line and the way-office of one or more other lines, as shown on the diagram at Baltimore, which is the terminal office of the Baltimore and Wilkesbarre line, and the way-office of the Washington and Philadelphia line. Harrisburg is also the way-office of the Baltimore and Wilkesbarre line, and the terminal office of the New York and Harrisburg line. Similar offices are shown at Binghamton and Springfield. Other arrangements of offices may be found upon the diagram, and will readily suggest themselves as the occasion for their use arises.

The terminal stations of each telegraph-line have the usual ground-connections F, and each station of a line is provided with a local battery, G, the object of which arrangement is to augment and re-enforce the electric currents as they pass along the line by the battery at each station.

In carrying out my system I employ at each station of a telegraph-line one or more recording-instruments, a transmitting-instrument, a reproducing-instrument, and one or more printing-instruments, all of which I will presently describe in detail, in the order named.

All the instruments of a line are harmonized with each other, so that the record of one station may be automatically reproduced in fac-simile at all the others, and the instruments of all the lines constituting a route must be the same, and operate in harmony with each other, in order that either an original record-fillet or a reproduced record-fillet of one line may be used to automatically operate any other line of the route. The junction-offices of a route are provided with a set of instruments for each line, and the different sets have no electric connection with each other.

The record-fillet, which constitutes the first step in the system, may have the message-signs indicated in or upon it by a variety of characters or marks without departing from the principle which governs the working of the process. One convenient method consists in forming the record of a narrow ribbon or fillet of paper, in which are cut two rows of slits, arranged to be read alternately from one row to the other, and indicating by their length the letters of the alphabet and other message-signs. This record-fillet is shown upon Sheet 2 of the drawings.

I arrange the letters in the order in which they most frequently occur in telegraphic messages, designating for the one that most frequently occurs the shortest slit, and increasing the length of the slits as the occurrence of the letters diminishes. The most frequently used sign in telegrams is the "separatrix" or space between words. This I make about one-half an inch in length. The order in which the letters of the alphabet most frequently occur is as follows, to wit: *e t i a o s r n h d l c u f m p b w y g v k x q j z*. For these I make the slits increase in length about one-sixteenth of an inch for each one, in the above order. For example, the separatrix being one-half an inch long, the slit for the letter *e* is made nine-sixteenths of an inch long; for the letter *t*, ten-sixteenths, and so on. The sign for "finis," or the end of a message, should be one-sixteenth of an inch longer than the sign for *z*, the last letter of the alphabet.

These lengths and this order are not imperative, being used here principally to illustrate the invention.

I will now proceed to describe the recording-instrument, referring to the drawings contained upon Sheets 3 to 6, inclusive.

A is the frame of the instrument, made in any suitable form to receive the working parts, and B is the main driving-shaft, arranged transversely of the frame, with its bearings in the bars G H. I Z are cams secured to the inner end of the main shaft, with their shoulders upon opposite sides thereof, and O is a rock-shaft, having its bearings in the sides of the frame, near the rear end. O′ is a sleeve mounted loosely upon this shaft, and provided with a slotted arm, N, which is connected by a rod, M, to the outer cam of the main shaft. Instead of making this connection directly with the cam, it may, if found desirable, be formed by a crank-arm on the end of the main shaft.

The rock-shaft O is further provided with a central fixed collar, carrying arms T V at an angle to each other. The arm T is formed with a lateral lug, carrying a set-screw, u, to bear against a corresponding lug upon the arm N, while the arm V is connected with a vertical rack-bar, f'', by the pivoted rod i', as shown in Fig. 3. S S are upright arms, firmly secured to the ends of the rock-shaft, and jointed at their upper ends to the arms a'' of a transverse stop-bar, c'', whose ends lie within longitudinal grooves formed in the side pieces of the case near the upper edges. W is a spring coiled about the rock-shaft, with one end secured to one of the arms S, and the opposite end to a collar, x, upon the sleeve O'. The collar is adapted for adjustment upon the sleeve by a set-screw, y, or other suitable means, to regulate the tension of the spring.

From the foregoing description it is evident that when power is applied to rotate the main shaft, the stop-bar will be moved back and forth within the grooves of the case, and that the rack-bar f'' will be reciprocated vertically. The extent of this reciprocation is regulated by adjusting the end of the connecting-rod M within the slot of the arm N, while the path of reciprocation is changed by adjusting the set-screw u to regulate the distance between the arms T and N. The tension of the spring is sufficiently strong to oscillate the rock-shaft and carry forward the stop-bar when the main shaft is rotated; but if the forward movement of the bar should be arrested before reaching its maximum throw, the tension of the spring will be overcome, so that the main shaft shall complete its rotation. E is a sleeve, mounted upon the main shaft, provided with a fly-wheel, D, and a grooved pulley, C, to receive the driving-belt of the instrument.

Inasmuch as the power applied to the sleeve must drive it continuously, and inasmuch as it is absolutely necessary that the main shaft shall rotate intermittingly, the sleeve is adapted to grasp and rotate the shaft by friction. For this purpose one-half of the sleeve is held to the other half by set-screws and springs e^{12}, which may be adjusted to regulate the degree of friction, and therefore the force with which the sleeve shall hold to the shaft. The sleeve is lined with leather or other pliable material, for the purpose of equalizing the friction and preventing unequal wear. The force of the sleeve must be sufficiently great to overcome the tension of the coiled spring when the stop-bar is arrested in its forward movement, and at the same time slight enough to allow the sleeve to turn continuously when the shaft ceases to move. Some connection of this kind is required for the successful operation of the instrument, since the intermittent rotation of the main shaft must be repeated many times in a second. The key-board of the instrument is composed of three banks of keys, divided into two sections, for the right and left hand of the operator, so that each bank of a section shall number five keys. The section-dividing board z''', together with the end boards y''' and front board a'''' of the case, forms guides for the fingers of the operator, so that he can look up to read a message while manipulating the keys. The boards y''' and z''' determine the stretch of the thumb and little finger, and so regulate the position of the intermediate fingers over the keys while guiding the hands in their backward and forward movements. The front board a'''' prevents the hands from going too far forward over the keys, and therefore forms a front guide at the upper bank. The keys are each pivoted upon a central pin, b'''', affixed to a suitable cross-bar, A^7. Their inner ends extend beneath the path of the stop-bar c'', and are properly weighted, so as to rest, when not in operation, upon a rear cross-bar, d'''', as shown in Fig. 3.

As the signs which represent the letters of the alphabet and other message-symbols are formed by slits of different lengths in the fillet of paper, and since the slitting-instruments are operated by the rack-bar in a manner to be presently described, it follows, in this example of my invention, that the throw of the rack-bar must be varied in proportion to the length of slits required. This is accomplished by suitable stops upon the upper edges of the keys to arrest the stop-bar at graduated distances in its forward movements. The result may be attained in a variety of ways; but in this instance I have shown the keys formed with shoulders upon their upper edges at varying distances from their inner ends, such distances increasing from right to left of the key-board, presenting the diagonal line shown in Fig. 2.

Since certain letters occur more frequently than others in telegraphic messages, which necessitates their representation by short slits in the fillet of paper, I have transposed the alphabet and placed the letters in such order upon the shoulders of the keys that the stop-bar will move the shortest distance for the most frequently occurring letter, the length of its strokes being gradually increased in proportion to the decrease in the occurrence of the letters used. By this means the recording mechanism may, through the medium of the stop and rack bars, be operated with great rapidity within a given time. The letters of designation are duplicated in the same order as the finger ends of the keys, as shown in Fig. 2. h''' is a lever, hung upon a cross-shaft, e'''', of the case, beneath the bar A^7, and forked at its inner end to embrace the cams I Z on the main shaft, one arm, c'''', of the fork bearing against the shoulder b''' of the cam I, and the other arm, m'''', at the proper time bearing against the periphery of the cam Z. The forked end of the lever should be sufficiently heavy to hold the arm c'''' in contact with the shoulder b''', and to return it rapidly against such shoulder after having been lifted. K'''' is a cross-bar arranged under and against the forward portion of the keys, and connected to the ends and center of the shaft e'''' by arms i'''' and the short arm of the forked lever. As above described, the power is applied to drive the friction-sleeve and fly-wheel of the instrument continuously; but the rest of the mechanism is motionless until the operator presses a key down upon the cross-bar K''''. This movement lifts the inner end of the detent-lever, and releases the cam I, so that the friction-sleeve shall revolve the main-shaft, and, through the intermediate devices, throw forward the stop-bar until it is arrested by the shoulder of the depressed key. The rack-bar, by this operation, is carried down in proportion to the distance traveled by the stop-bar, starting always from the same point—that is to say, it always starts downward from the same point, but descends differentially in proportion to the throw of the stop-bar.

These various parts constitute the mechanism for operating the recording devices, which I will now proceed to describe in connection with their method of operation. M'' is a horizontal bed for guiding the fillet of paper upon which the message is recorded, and n'' is a sleeve secured to its under side, so as to fit upon an upright spindle, l'', affixed to the frame in rear of the key-board. The guide-bed is arranged transversely of the case, and may be pivoted to the top of the spindle by a screw-pin, b^5, as shown in Fig. 4. A^1 A^1 are uprights of the frame, placed in line with the guide-bed to receive the feeding mechanism, by which the fillet of paper is drawn through the instrument. p''''' is a spring connecting an arm, o'', of the sleeve n'' with an adjusting-pin, q'', at the base of the outer upright, for the purpose of holding the guide-bed in position with a yielding connection. r'' is a stop attached to the case within the path of the arm o'', and adapted for adjustment to regulate the lateral swing of the guide-bed. By this method of mounting and connecting the guide-bed it is automatically adjusted with delicacy and precision, to compensate for any irregularities in the running of the paper, and to insure accuracy in its presentation to the recording-blades and feeding-cylinder. O''' is an arm projecting to the rear of the guide-bed sleeve n'', and provided with a lateral pin, r''', upon which the paper-reel q''' is hung. q' is the paper, wound upon the reel beside a flange or rim, p''', formed upon the latter, and thence passing upward, on its way to the guide-bed, through a guide-loop, v''', formed upon the upper end of a lever, t'''. The inner end of the paper is secured to the reel in any convenient manner to prevent it from slipping. The lever carries a friction-brake, S''', and is hung to the side of the arm O''', so that, under the force of a spring, w''', it shall press the guide-loop away from the bed, and the brake down upon the flange of the reel.

When the instrument is in operation, the feeding devices pull the paper over the feed-bed with slight, but rapid, jerks, which carry the guide-loop v''' toward the guide-bed, and lift the friction-brake from the reel, so that the latter may turn and release the paper. When the paper ceases to move, the spring throws out the upper end of the lever t''', unwinding the paper from the reel until the friction-brake comes down against the flange thereof, and arrests its further rotation.

To increase the quantity of paper pulled off the reel in proportion to the increase in the length of the message-slits, it is passed over an intermediate guide, x''', affixed to the end of the guide-bed, before passing over the guide v'''. After leaving the reel-guides the paper rests upon the bottom of the guide-bed, and is held against the adjustable outer or gage side S'' thereof by means of shoulders formed upon arms w'' x'', which are connected by a longitudinal bar, y'', and slide within deep transverse grooves in the bottom of the bed, as shown in Fig. 2. The shoulders are held against the fillet of paper, so that they shall conform to its varying width, by one or more springs, c''', arranged to bear against the outer side of the bar y''.

The pressure of the springs is adjusted by set-screws e''', passing through the inner side rail of the bed, or otherwise arranged in any other convenient manner. A pin, m''', fixed to the bottom of the guide-bed, limits the advance of the yielding shoulders when the fillet of paper has passed out of the machine. t'' is a cover or pressure-bar, hinged to the outer edge of the guide-bed, so as to hold down the fillet of paper, the amount of pressure or friction being regulated by the set-screw n''', Fig. 1, upon which the free edge of the cover rests. The cover may be weighted or held down by a spring, if preferred; but its own weight will, in most cases, probably be found sufficient for all purposes. Its outer edge is formed with suitable recesses or spaces j''', k''', and i''', to prevent the outer edge of the paper from folding up as it passes over the guide-bed and along the guide-side S''. l''' is a handle affixed to the cover, for opening and closing it in applying or removing the paper.

The ends of the transverse guide-arms w'' x'' extend through the gage side S'' of the bed, in line with the hinges of the cover, so that when the latter is thrown open for the insertion of a fillet of paper the upper leaves of the hinges shall bear against the ends of the arms, and force back the guide-blocks. The opening of the cover, therefore, prepares the bed for the application of the p per.

r^2 are slotted guide-blocks attached to the inner end of the guide-bed, so that their upper surfaces shall lie flush with the top of the bed. They are each formed with a slotted arm, r^3, extending under the bed for the passage of holding-screws, by which the blocks are independently adjusted with respect to the bed and its gage-side, to regulate the distance apart of the slitting-blades and the position of the slits in relation to the edges of the paper.

Instead of making the blocks in separate pieces, and attaching them to the bed, they may be made directly upon the end of the latter, if preferred.

f^3 are corresponding slotted guide-blocks, attached to the cover of the guide-bed by set-screws m^3, so that their slots shall register with those in the blocks r^2. Each of the blocks f^3 carries an embossing roller or style, i^3, within its slot, to bear down under the weight of the cover upon the fillet of paper in its passage over the bed, and, by pressing it into the grooves of the lower blocks, to form two parallel tracks or creases.

The edges of the grooves in the lower blocks may be beveled or cut out in any manner to render the tracks in the paper distinct, or to give them any desired peculiarity or characteristic in design. The creases are intended to receive the track-hand of the transmitting-instrument while certain electric changes are effected, which will be hereinafter described as a subsequent step in my process.

Set-screws n^3, passing through the blocks f^3, serve to adjust the pressure of the styles upon the fillet of paper. l^3 l^3 are recesses in the under side of the blocks f^3, to receive a strip of leather, rubber, or other soft material, for the purpose of forming yielding anvils for the points of the slitting-blades, which anvils are adjusted by set-screws m^4, as shown in Fig. 4. v'''' is a horizontal shaft, having its bearings in parallel arms v^5, projecting from the guide-bed sleeve toward the uprights A^1. It carries a pinion, w'''', and two vertical eccentric bars, n^2, the upper ends of which latter pass upward through the slots of the blocks r^2, being guided by the slots and pins S^2, as shown in Fig. 4. N^3 are pointed reversible knives, attached to the front of the eccentric bars by the slotted bosses c^3 and set-screws d^3, so that the point of each shall enter the grooves in the guide-blocks r^2. a''''' and b''''' are radial pins or detents, affixed to the shaft of the eccentric bars to engage with teeth c^2 d^2 upon the arms of a forked lever, h^2, and form an escapement. The lever h^2 is mounted upon a shaft, u'''', in rear of the eccentric shaft; and its lower arm g^2 extends forward within the path of a pin, m^2, on the side of the rack-bar, while its rear end is connected by a spring, i^2, to an adjusting-pin, j^2, on the guide-bed. l^2 is a stop attached to the sleeve of the guide-bed, to limit the upward throw of the lever h^2 under the tension of its spring. n'''' is a gear-wheel, secured to a shaft, o'''', which is mounted in suitable bearings of the case, so that the gear-wheel shall engage with the pinion w'''' on the eccentric shaft. r'''' is a drum, fastened to a long tubular bearing, r^6, on the shaft o'''', and containing a coiled spring, r^7, one end of which is secured to the gear-wheel, and the other end to the interior of the drum. s'''' is a friction-sleeve, mounted upon the tubular bearing, and constructed and applied thereto in the same manner as the sleeve of the main driving-shaft. The outer end of the sleeve carries a grooved pulley, t'''', which is driven by a suitable arrangement of belts from the prime mover of the instrument to rotate the gear-wheel intermittingly, in a manner similar to that in which the main driving-shaft is rotated by its sleeve, as already described.

When the instrument is operated, as hereinbefore described, the fillet of paper is drawn over the guide-bed by suitable feeding mechanism, operated by the rack-bar from the keys of the instrument.

The bar is arranged in suitable guides of the case, and when a key is depressed it commences to descend. This movement releases the arm g^2 of the escapement-lever from the pin m^2 on the bar, and permits the spring i^2 to draw up the arm h^2, and disengage the tooth d^2 from the detent b'''''. The shaft v'''' is thus released, so that it may make half a revolution, or, rather, so that it may revolve until the same detent b''''' is arrested by the tooth c^2 on the upper arm of the lever. When the rack-bar again moves up, it lifts the arm g^2 of the escapement-lever, throwing the lower tooth d^2 upward to catch the lower detent, and clearing the upper tooth c^2 from the upper detent, so that the eccentric shaft may be again moved when the rack-bar makes its next descent. One complete vibration of the forked lever, therefore, alternately clears a detent from one tooth and allows the shaft to make a half-revolution.

The detent or eccentric shaft is driven from the shaft o'''' through the medium of the gearing n'''' w'''', and, as the rack-bar descends, throws up one of the eccentric bars, so that the point of its knife shall enter the fillet of paper and there remain until a slit is cut equal in length to the distance the paper moves.

The length of the slit indicates a particular letter or symbol of a message, and such length is controlled by the forward throw of the stop-bar, and the consequent descent of the rack-bar, as previously explained.

The greater the throw of the stop-bar the lower the rack-bar will descend, and the lower this bar descends the longer the blade will remain in the paper, and therefore the longer will be the slit cut therein.

The eccentric bars are so arranged that the two blades are alternately thrown up to puncture the paper in parallel lines, thus making a record which must be read from one line to the other alternately.

The feeding devices are constructed and operated as follows: j is a horizontal shaft, having its bearings in the uprights A^1. K' is a cylinder mounted upon the shaft in line with the recording devices, and provided with several rows of sharp teeth, which take hold of and feed the paper when the cylinder is rotated. It is also formed with peripheral grooves, in line with the grooves of the guide-blocks r^2, to receive the embossed creases in the fillet of paper, and prevent them from being flattened out or otherwise injured.

L is a pressure-roller mounted upon an arm, f', pivoted to one of the uprights A^1, so as to place the roller in front of the cylinder.

The pressure-roller, under the force of an adjustable spring, h'', holds the fillet of paper against the teeth of the cylinder, so as to insure the proper feed. The surface of the roller should be made of or provided with leather, or some suitable yielding substance, to receive the impress of the cylinder-teeth and prevent the paper from slipping.

o' and p' are ratchet-wheels mounted upon the shaft j, with their teeth pointing in opposite directions. j' is a small gear-wheel mounted loosely upon the shaft j, between the ratchet-wheels, so as to engage with the teeth of the rack-bar.

When, in the operation of the instrument, the rack-bar is moved upward, a spring-pawl, m', pivoted to an arm, l', of the gear-wheel, engages with the teeth of the ratchet-wheel o' and moves it forward, together with the feed-cylinder and ratchet-wheel p'.

A spring-pawl, v', pivoted to one of the uprights, engages the ratchet-wheel o', to prevent any backward movement of the feed-cylinder when the pawl m' ceases to act.

z' is an angular lever, pivoted at its angle to one of the uprights immediately under the wheel p', and having teeth formed upon its upper arm, which, when the rack-bar is thrown up, engage with the teeth of the wheel p', and lock it against further movement. This locking mechanism, which is thrown into operation at the termination of each upward movement of the rack-bar, prevents the feed-cylinder from being carried too far by its momentum after the rapid throw of the pawl m'.

The angular or locking lever is operated by an adjustable stop, w', on the side of the rack-bar, which strikes against the free end of a spring, z'', lying along the under side of the upper lever-arm, as shown in Fig. 1.

The spring insures the action of the locking-lever, and is limited in its downward movement by a stop, y', formed at the angle of the lever.

A recess, x', in the edge of the rack-bar receives the lower end of the locking-lever, to permit its necessary movements in locking and unlocking the feed-cylinder.

It will thus be observed that the movements of the rack-bar govern the movements of the paper, and therefore the length of the slits therein, while the movements of the rack-bar are governed by the operation of the keys, as hereinbefore described.

There is an equal number of teeth on the ratchet-wheels o' p'; but the number in each must be greater than the number of characters to be made, for the following reasons: Assuming that there are twenty-eight keys to the instrument, that the separatrix must be eight-sixteenths or one-half of an inch in length, and that the letters or characters following increase the slits in the paper one-sixteenth of an inch each, then there must be thirty-six teeth in the ratchet-wheel one-sixteenth of an inch apart, because the moving pawl, starting always from the same point, must, as the rack-bar descends, ride back upon the ratchet-wheel to engage the eighth tooth, and, when the rack-bar ascends, move forward the wheel until the pawl again reaches the point from which it started. Now, to make the next letter, say E, the pawl travels back to the ninth tooth; to make T, it moves back to the tenth tooth; and to form the longest character, or the one least used, it must travel back thirty-six teeth. This latter movement, however, would require a complete circuit of the ratchet-wheel by moving the pawl, which could not well be done without interfering with the locking-pawl. I therefore add a few teeth to the ratchet-wheel, to engage the locking-pawl between the point from which the moving pawl starts and the point reached by its longest throw.

It may be here observed that though the ratchet-wheel and cylinder might operate if both were made of the same diameter, yet a practical difficulty intervenes, because the best size for the cylinder is such that the teeth of the wheel would be too fine to insure the action of the driving-pawl in its rapid movements. It therefore becomes necessary to make the ratchet-wheel greater in diameter than the cylinder.

The shoulders upon the keys of the instrument govern the movement of the rack-bar, and must, therefore, be arranged in proper relation to each other and to the teeth of the ratchet-wheel. The distance traversed by the stop-bar in moving down the rack-bar to form the separatrix represents the distance traversed by the moving pawl upon the ratchet-wheel, which, as above stated, is the distance of eight teeth. To make the next character, the stop-bar travels along the adjoining key the same distance and one-eighth more, its throws increasing in this proportion through the whole number of keys. Therefore the shoulders of the keys are separated from each other one-eighth of the distance the stop-bar travels to reach the shoulder of the first or separatrix key.

I have only used the proportions and distances above named to illustrate the principle of operation, as it is evident that they, as well as the mechanism, may be varied indefinitely. By this means the feed-cylinder and keys operate in unison to regulate the feed of the paper, and therefore the length of the slits which form the record thereon. i'' is a curved guide, secured to the uprights beneath the feed-cylinder, for the purpose of guiding the paper out of the instrument.

Where large numbers of messages are to be sent, much time is consumed by the operator in placing them in position to be read and recorded. To avoid this unnecessary delay I propose to mount the messages in a rack connected, through suitable mechanism, with an operating-key, by whose movements the messages are successively exposed to view, and then moved to one side out of the way.

Referring to the fourth sheet of drawings, a^9 is an inclined table, supported upon the case of the instrument over the keys, and provided at its upper and lower edges with grooves to receive the parallel bars a^7 and b^4. These bars slide freely within their grooves, and are connected together at their rear ends by a strip of wood or metal, b^{15}, which is adapted for ready removal when necessary.

The bar b^4 is formed with a rack along its under side to engage with a pinion, b^8, mounted upon a short shaft, b^7. This shaft also carries the reversed ratchet-wheels b^9 and c^4, and has its bearings in an upright, c^{10}, of the case A, and in the end of a hand-lever, b^6, pivoted to the lower edge of the table. The pivotal point of the lever is removed a short distance from the shaft b^6, and the inner end of the latter fits loosely within its bearings c^{10}, so that, when the outer end of the lever is raised or lowered, the shaft may be moved to engage or disengage the pinion and rack-bar.

One of the keys in the key-board of the instrument—preferably the left-hand one in the middle tier—is formed with a bent arm extending upward in rear of the fulcrum-pin c^9, which arm carries a fixed pawl, c^6, and a spring-pawl, c^5, to engage the reversed ratchet-wheels c^4 and b^9, respectively.

a^4 a^4 represent a series of spring-fingers, secured one behind the other to pins a^5, projecting from the upper edge of the sliding bar a^7 in the plane of the table. These fingers are folded over upon each other, as shown in Fig. 6, and the upper edges of the messages are inserted between the springs, the main portions lying upon the table. The messages therefore rest upon each other like the leaves of a book, the upper one only being exposed to view, so as to be read.

When it is desired to move a message out of the operator's view, in order to expose the message next behind it, the key is depressed, so that its inner end shall lift the spring-pawl and rotate the ratchet-wheels one tooth. This movement, of course, rotates the shaft and its pinion, and moves the rack-bar b^4, together with the bar a^7, toward the left of the instrument until a point, a^6, on the lower end of a spring-finger is brought in contact with a lug, a^8, projecting from the upper edge of the table, to turn the finger over, as shown in Fig. 6. The message held by this finger is therefore turned over, and exposes to view the message held by the finger next behind it. As the message is turned the fixed pawl c^6 engages the other ratchet-wheel, and locks the series of fingers against further movement until the key is again depressed. When the message has been turned over and the key released the weight of the latter restores it to its normal position, ready for the next movement.

The ratchet-teeth should be made of such size that, when the spring-pawl moves the ratchet-wheels one tooth, the bar a^7 will be carried to the left the distance between two pins, a^5, the latter being arranged at equal distances apart.

The bar a^7 is designed to hold from twenty-five to thirty messages, and, when all have been recorded, the outer end of the hand-lever b^6 is raised, the strip b^{15} disconnected from the bar a^7, and the latter removed for the insertion of another, carrying a fresh lot of messages.

For the purpose of cutting off the fillet of paper after the record has been made, I arrange a pair of shears or cutters in rear of the feed mechanism, and operate them by one of the keys of the instrument in the following manner, employing, preferably, that key which is arranged in the upper tier, immediately over the key for turning the messages: The inner end of the key selected extends upward through the case in rear of the fulcrum-pin c^9, and is slotted to receive the arm g^4 of an angular lever pivoted, at g^5, to one of the uprights A^1. The upper arm of this lever is pivoted to the outer end of a horizontal cutting-blade, g^6, which is arranged between the uprights of the case, and pivoted at its inner end to a projection, g^7, of the rear upright. This cutting-blade works over the edge of a second horizontal blade, g^8, affixed to one of the uprights, so as to project immediately under a loop, g^9, formed upon the upper end of the curved guide i''. The fillet of paper, guided by the loop, passes down between the blades, and is cut off by depressing the operating-key, so as to throw the swinging blade against the fixed blade, the two operating with a shearing cut. A spring, g^{10}, coiled about the upper arm of the crank-lever, and connecting with the pivoted blade, forces the latter down upon the fixed blade to insure the cutting operation.

When the key is released the weight of its inner end restores it to its first position, and swings the pivoted cutting-blade outward, so that the fillet of paper may continue its downward passage.

The fixed blade is placed against a shoulder formed in the curved guide, or is otherwise connected to the latter in such a manner that its cutting-edge shall lie in or behind the plane of the guide. Some arrangement of this kind, in connection with the guide-loop g^9, is absolutely necessary to properly guide the fillet of paper after the cut is made; otherwise the end of the main fillet would fly out of the guide, and have to be replaced between the blades by hand before a second cut could be made.

Instead of arranging the pivoted blade to swing over the fixed blade, it may be arranged to pass under it, the spring being also changed to press the swinging blade upward instead of downward.

The message to be sent having been recorded in the fillet of paper by the recording-instrument, the next object to be attained is the transmission of such recorded message along the telegraph-line, and the reproduction of a fac-simile thereof at any or all the stations. This may be carried into practice in many different ways without departing from my invention, one of which ways I will now proceed to describe.

In the accompanying drawings, A is the frame of the instrument, constructed in any suitable manner, and provided with two uprights, A^1, which support the main driving-shaft B. This shaft is employed to operate two sets of feeding devices—viz., one set by which the fillet of paper containing the record is fed through the instrument for transmitting a message, and the other set for feeding along another fillet of paper, in which a received message is recorded, so as to constitute a fac-simile of the record from which the message was sent.

For a proper understanding of the invention, and to prevent confusion in description, it is necessary to bear in mind that each station along a telegraph-line is provided with two instruments, in addition to the one by which the record is first made—to wit, one for transmitting and receiving, and one for reproducing a transmitted message.

It is evident, therefore, that a message may be received and reproduced at one station without being transmitted to another.

The shaft B is supported in its bearings upon friction-wheels *u*, placed within the uprights of the frame, and is provided with a fly-wheel, C^2, and the cylinders D E. These cylinders, in connection with pressure-rollers, are employed to feed the fillets of paper through the transmitting and reproducing instruments, and are each formed with several rows of teeth, to take hold of the paper, and with two peripheral grooves, to receive the embossed tracks in the fillets.

The grooves should be the same distance apart, in order to register with each other and the grooves in the cylinder of the recording-instrument, so that the embossed tracks in the paper containing the record may fit the grooves of all the cylinders.

The shaft is driven by two collars connected thereto, so as to clamp the hub of the driving-wheel between them by frictional contact, and transmit its motion to the shaft. The wheel is driven by electro-magnetism, as I will presently describe.

For the purpose of controlling the speed of the shaft I regulate the frictional contact of the collars and hub of the driving-wheel by means of a governor, consisting of the crossed levers G, carrying balls F upon their ends, and pivoted together upon the shaft between the cylinder D and fly-wheel C^2 by a screw or pin, I. One-half of the shaft is cut away for this purpose, and after the parts have been applied a protecting-cap, I′, is placed over them upon the shaft, as shown in Fig. 4.

L L are short links, pivoted at one end to the upper and lower governor-levers, and at the opposite end to a rod, M, extending within the shaft toward the hub of the driving-wheel S, the shaft being made hollow for this purpose. The other end of the rod carries a pin, Q, which projects through a slot in the shaft, so as to connect with an exterior collar or ring, P. This collar is adapted to slide freely upon the shaft, and is formed upon opposite sides with two projections, each containing a conical recess. A second ring, P′, is mounted upon the shaft, but is fixed thereto between the ring P and fly-wheel. It is also provided with projections having conical recesses, and the two rings are united by pointed pins R, placed between them, with their points in the conical recesses. This arrangement is employed to prevent the holding and guiding pin Q from binding within the slot of the shaft when the collar P is being moved by the governor.

The driving-wheel S is made with a long hub, fitting loosely upon the shaft, and terminating at its inner end in a grooved pulley, *h*.

i is a collar or plate, mounted upon the end of the shaft, so as to bear against the flat outer end of the wheel-hub, and held in place by the enlarged head of an adjusting-screw, *l*, fitting into the end of the shaft.

The collar is prevented from turning upon the shaft by a short tongue projecting from its inner circumference into a slot or groove in the shaft, which slot should be of sufficient length to permit the adjustment of the collar and wheel when required.

The two collars P and *i* clamp the hub of the driving-wheel between them, and thereby transmit its motion to the shaft.

g g are washers, of cloth, leather, or other suitable material, placed upon the shaft between the collars P *i* and the ends of the wheel-hub, for the purpose of increasing the friction between such parts and preventing wear.

H are bent springs interposed between the governor-levers upon opposite sides of the shaft, and exerting their force outward, so as to spread the levers apart and hold the collar P and wheel-hub against the outer collar *i*, or, in other words, to preserve the frictional connection between these two collars and the hub by spreading the governor-levers, so as to straighten the toggle-joint formed by the connecting rod M and links L.

When the speed of the shaft becomes too high the governor-balls are thrown outward by centrifugal force, overcoming the tension of the springs H, and causing the links L to spread apart and, by retracting the connecting-rod M, withdraw the collar P from the wheel-hub. This breaks the frictional connection between the two, and allows the shaft to decrease in speed until a reduction of the centrifugal force causes the governor-balls to approach the shaft and again establish the connection.

The force with which the wheel-hub is clamped between the collars is regulated by adjusting the collar *i* upon the shaft, so as to press the hub with greater or less strength against the collar P, when the shaft is at rest. This pressure, of course, is continued for a longer or shorter period, according to the adjustment, when the shaft is in motion.

The bent springs counterbalance the centrifugal force of the governor-balls until the shaft has attained, or nearly attained, the speed requisite for feeding the fillet of paper in transmitting and recording a message, and their tension may be adjusted by any suitable means, to regulate the centrifugal force required for throwing out the governor-balls and disconnecting the friction-collars from the wheel-hub, or, in other words, to determine the speed at which the shaft shall run to feed the paper; but as the weight of the balls is considerable, and a strong spring is necessary to counterbalance their centrifugal force, and as the spring requires a very delicate adjustment, I prefer to construct the apparatus in such manner that the stout bent spring shall operate to counterbalance the centrifugal force of the balls up to nearly the speed required, and that additional auxiliary springs, capable of fine adjustment, shall be employed to furnish the force that is necessary, over and above the force of the bent springs. These auxiliary springs J J are made in the form of spirals, and are arranged to connect two governor-balls across the shaft, being secured to adjustable friction-pins T, which are held in the balls by set-screws K. By means of the set-screws and friction-pins the tension of the springs J can be finely adjusted, to determine the force required in excess of the bent springs to counterbalance the centrifugal force of the balls that is necessary for disconnecting the friction-collars and wheel-hub. The speed of the shaft, and therefore the movement of the paper, can be correctly gaged to correspond in all the instruments along the telegraph-line, and thereby insure accuracy in transmitting, recording, and reproducing a message, or, in other words, so that the slits in the fillet of paper which constitute the recorded message shall be of the same length for the respective signs at all the stations.

The distance to which the governor-balls are thrown out centrifugally is fixed by arms H^2, arranged between the bent springs, or by any other device suitable for the purpose.

N N are racks projecting transversely of the shaft, from that part of the governor-levers next the fly-wheel, to engage, respectively, with the upper and lower side of a pinion, K′, which is mounted within the shaft so as to rotate at right angles thereto. This arrangement of mechanism is employed to equalize the movements of the governor-balls, and is best shown in Fig. 6 of the drawings. An equivalent of this device would be an arm from each lever extending toward each other from opposite sides of the shaft, and articulated to opposite ends of a lever pivoted in the center to the shaft, which construction I propose to use when desired.

Motion may be imparted to the shaft B in a variety of ways, one of which consists in connecting the motor to the grooved pulley *h* by a band; but for convenience and economy I employ electro-magnetism, in the following manner: On the long hub of the driving-wheel is placed an insulating-cylinder, *e*, provided with two grooved metal bands, *b b′*, and with two grooved intermediate half-bands, *c c′*, which are detached from each other at the ends. These various bands are arranged parallel to each other—the outer one, *b*, next the wheel, and the inner one, *b′*, on the inner end of the hub.

w w^1 w^2 w^3 are metallic joints attached to the frame of the machine beneath the driving-wheel to support upright arms y^2 in front and rear of the hub, and a a^1 a^2 a^3 are beveled rollers hung upon the upper ends of the upright arms, so as to fit within the grooved bands in the following order, viz: the roller a within the half-band c', the roller a^1 upon the same side of the hub within the band b', the roller a^2 within the band b, and the roller a^3 within the half-band c. a^{10} are insulating-eveners connecting each pair of upright arms y^2 upon opposite sides of the hub, and a^{11} is a spiral spring connecting the two eveners, so as to draw the arms toward the wheel-hub and press the beveled rollers equally against the grooved bands. The positive and negative poles of the battery employed are connected, respectively, to the joints w and w^3, while the two remaining joints, w^1 w^2, receive, in the order named, the ends o^6 and o^7 of a helix placed within a magnet, D′′′′′, which is suitably arranged upon the frame and properly insulated therefrom. This magnet is composed of two covers or plates, O O′, of soft iron, mounted one upon the other, so as to inclose the helix between them; but the helix is insulated from the covers, and its convolutions are insulated from each other. w^5 is a rock-shaft, (shown in Fig. 14,) arranged diametrically of the covers, and provided with a series of permanent magnets, *s*, which are alternately attracted and repelled to oscillate the shaft when the charge of electricity from the battery is sent through the helix to magnetize the covers. w^4 is an upright rod firmly fixed to the rock-shaft of the magnet, and jointed at its upper end to an arm, Z, which, in its turn, is pivoted to a wrist-pin on the side of the driving-wheel. By this means the driving-wheel is rotated when the rock-shaft is oscillated by the changes of polarity in the magnet. By giving the permanent magnets *s* a long oscillation within the soft-iron covers, and arranging the wrist-pin of the driving-wheel to correspond therewith, more power is obtained from the same magnet than could be obtained if the oscillations were short. For this purpose the covers are so constructed that the distance between them shall be greatest at the arcs through which the ends of the parallel magnets move, as shown in Fig. 19.

The simplest method of effecting this change of polarity is to send the charge from the battery through the positive roller *a* and its half-band *c'*, thence through the whole band *b*, such bands being suitably connected, and from the band *b*, through the roller a^2 and its arm, to the end o^7 of the helix. This tips the parallel magnets in one direction to move the driving-wheel, and, as the latter rotates, it brings the half-band *c'* in contact with the negative roller a^3, and the half-band *c* in contact with the positive roller *a*. The band *b'*, having a suitable connection with the half-band *c*, conducts the current to the roller a^1, and thence to the end o^6 of the helix, for the purpose of changing the polarity of the magnet and oscillating the rock-shaft in the opposite direction.

By this constant change in the polarity of the magnet, the rock-shaft is oscillated to rotate the driving-wheel continuously, as above stated.

For the purpose of equalizing and regulating the speed of the shaft, I employ a governor in connection with the driving-wheel; and to prevent an unnecessary waste of power generated by the battery, I employ a resistance-coil in connection with the governor. This governor is composed of a ring, x^2, held at the face of the driving-wheel by radial arms x^3, which together form a rock-shaft, having its bearings at the rim of the wheel, but insulated therefrom. The ring is further provided upon opposite sides, at right angles to the shaft, with two governor-balls, x^4, arranged in line with each other, one being adapted to carry a platina-faced conducting-roller, x^5.

The normal position of the governor is such as to hold the two balls at an angle with the face of the driving-wheel, and is effected by means of an adjustable spiral spring, v^4, connecting the end of an adjusting-pin, *v'''*, at the inner face of the wheel, with an arm, u^2, projecting from the ring inward toward the wheel hub. The tension of this spring pulls the inner end of the arm outward toward the face of the wheel, and therefore holds the two balls inclined to its axis of rotation.

v v' are conducting-springs, insulated from and arranged beside each other upon the wheel outside the governor. One end of each is secured to, but insulated from, the wheel, while the opposite end is free and lies in the path of the governor-roller x^5. When the driving-wheel is at its lowest speed, the governor-balls occupy their greatest inclination to its face, and hold the roller x^5 outside and out of contact with the conducting-springs. As the speed increases, the governor is thrown in by centrifugal force to a position nearer at right angles to the axis of rotation, and therefore carries the roller in contact, first, with the outer spring *v'*, and then with the inner spring *v*. The tendency of the spring v^4 is to counterbalance the centrifugal force of the governor and return it to its normal position, as above stated.

The outer spring *v'* has electric connection with the half-band *c'* on the wheel-hub, and the governor-ring has a similar connection with the whole band *b*. When, therefore, the current of electricity is sent through the positive roller *a* into the half-band *c'*, it passes from the latter to the outer spring *v'*, and if the driving-wheel is moving at low speed, so as to carry the roller x^5 in contact with such spring, the current passes along the spring to the roller, thence down the roller-arm to the ring, and into the band *b*. From the band *b* it passes to the helix for oscillating the permanent magnet, the rotation of the driving-wheel changing the direction of the current from the positive roller to the half-band *c* and band *b'*, the two being directly connected, and therefore changing the polarity of the magnet and continuing the rotation of the wheel, as hereinbefore described.

Now, if the governor-roller should constantly maintain its contact with the outer conducting-spring *v'*, the speed of the driving-wheel would increase until it attained too high a velocity for practical purposes. This is apparent from the fact that after the first change in the polarity of the magnet the wheel acquires a certain momentum, which effects the next change a little sooner, and so on until the wheel would be accelerated to such an extent as to make the current of electricity through the magnet almost continuous. This, of course, would consume the whole power of the battery, and therefore exhaust it much sooner than if only that power, or approximately that power, is employed to drive the wheel at the requisite speed. To prevent this exhaustion and waste of power, the inner spring *v* is employed, in connection with a resistance-coil, *u'*, which, for convenience, is wound upon the periphery of the driving-wheel, although it may be located at any point upon the frame of the instrument by suitable means. One end of the resistance-coil is connected to the inner spring *v*, and the opposite end to the outer spring *v'*. When the speed of the wheel becomes so great that its centrifugal force carries the governor-roller inward in contact with the inner spring *v*, and so breaks the circuit through the outer spring v^1, the positive current, passing from the half-band *c'* to the outer spring *v'*, as above described, goes through the resistance-coil to the inner spring *v*, thence to the governor-roller, and so on to the magnet, following the course already described. Since the short circuit formed by the governor-roller and outer spring is broken by the centrifugal force of the governor, the only course for the current to follow is through the resistance-coil. This diminishes the current somewhat, and therefore slackens the speed of the wheel to a slight extent, and allows the governor-roller to move outward toward the outer spring v', and again break the circuit through the resistance-coil. The governor-roller, therefore, acts as a circuit-breaker, breaking the circuit with one spring and closing it with the other alternately. It maintains a constant vibration from one to the other, rapidly throwing the resistance-coil into and out of the circuit, and consequently sustaining the wheel at a uniform velocity without exceeding the minimum quantity of battery-force required to perform the work.

When the instrument is at rest, the spring v^4 holds the governor-roller outward from the shaft B, and breaks the connection with both springs v and v'. To start it in motion, I have provided a holder, o^{10}, pivoted to the inner face of the fly-wheel, being insulated therefrom. By turning down this holder it presses against the inner governor-ball, and forces the governor-roller inward, in contact with the outer spring v', to close the circuit from the battery to the magnet. After the wheel has acquired momentum, the holder o^{10} is automatically thrown back against the wheel by coming in contact with a trip or stop, u'''', pivoted to a short upright, u''', of the frame beneath the driving-wheel. The stop is weighted, as shown at u^4, so as to keep it out of contact with the holder until it is swung into the path of the latter by the operator.

When the power of the battery is too slight to impart the requisite motion to the driving-wheel, the governor-roller is thrown inward by the counterbalancing-spring v^4, to break the circuit and stop the instrument, thus preventing it from transmitting or recording at too low a speed.

An induction-coil and local battery are placed at each station, and the main line is operated by passing a current from the battery alternately through two helices contained within the coil, but wound in opposite directions, as I will more particularly point out at its proper place herein.

In transmitting a message, therefore, from one station to another, the main line is worked by an induced current alternately reversed. The mechanism for effecting this reversion is constructed as follows, being operated by the fillet of paper containing the record to be transmitted as it is drawn through the instrument by the feed-cylinder E when the driving-shaft revolves.

O'' is a guide-bed, having a sleeve, O''', secured to its under side, so as to fit over an upright shaft, o', upon the main frame, and hold the bed in a horizontal position, in line with the feed-cylinder E, and in rear thereof.

The upright shaft is insulated from the main frame, and a front projection, n, of the sleeve is connected by a flat spring, n', with an adjustable holder, n'', attached to one of the front uprights of the frame. This forms a yielding connection, and permits a slight lateral swing to the bed, for the purpose of compensating for any irregularities in the movements of the paper containing the record to be transmitted, and to insure the proper guidance thereof to the feed-cylinder. The extent of this lateral swing is regulated by adjusting the holder n'' upon its upright. m m', Fig. 29, are two parallel grooves formed longitudinally in the upper surface of the guide-bed, to receive the embossed tracks made in the record by the recording-instrument. They are necessarily the same distance apart as the grooves in the feed-cylinder, and are also in line therewith, as shown. i''' is the inner side of the guide-bed, raised somewhat, and made adjustable by any convenient means, to regulate its position for guiding the edge of the paper, so that the embossed tracks shall be directed and held within the grooves of the bed. This adjustable side is also formed with recesses along its inner edge, as shown in Fig. 29, for the purpose of preventing the edge of the paper from curling up or wrinkling as it is drawn over the bed. i'''' is a pressure-bar arranged upon the opposite edge of the guide-bed, being secured to cross-bars i' i'', which slide within deep transverse grooves cut in the bed. The cross-bars are formed with shoulders, to bear against the edge of the moving paper and hold it up to the gage-side i''', while springs f', attached to the outer edge of the bed, and bearing against the pressure-bar, cause the shoulders to act with a yielding pressure, and therefore conform to the varying width of the paper. The pressure of the bar is regulated by set-screws f''', passing through the outer fixed edge of the bed, so as to bear against the springs, and the movement of the bar toward the gage-side, after the paper has passed out, is limited by a pin, f^6, driven into the bed near the outer groove, as shown.

m'' is a cover, hinged at the inner edge of the guide-bed to hold down the fillet of paper, the amount of pressure with which it bears upon the latter being regulated by a set-screw, f^5, passing upward through the bed, so that the cover shall rest upon its point. The cover may be held down by a spring, if desired; but I prefer to employ a weight, h', pivoted to one of the hinges, so that it may be swung round to regulate the weight of the cover on the adjusting-screw f^5. The ends of the cross-bars i' i'' project through the adjustable gage-side i''' of the bed, just beneath the upper leaves of the cover-hinges, and, when the cover is thrown open, these upper leaves bear against the projecting ends of the bars, and force back the guide-shoulders, thus preparing the bed to receive the paper fillet containing the record for transmission.

Two parallel V shaped ribs or rails extend along the under side of the cover, in such a position as to fit into the grooves of the bed, for the purpose of properly guiding the fillet of paper and preserving the form of the embossed tracks therein as it is drawn along over the bed. k''' is a short horizontal shaft, so secured to the edge of the cover as to extend across the middle thereof, and e''' e''' are hubs mounted loosely thereon. e' e' are light metallic track-fingers secured to the hubs, parallel to each other, and extending forward of the same, so that their points shall project down through openings in the cover and its ribs, and rest in the embossed tracks of the paper fillet on the bed beneath. Each hub is also provided with a short arm extending along the track-fingers, and the arms carry set screws k' at the end, the points of which bear against the sides of such fingers. j' is a block secured to the cover in front of the fingers, and formed with narrow slots, through which the ends of the fingers pass. These slots guide the fingers in the embossed tracks of the paper, while the set-screws k' serve to accurately adjust the position of the fingers within the tracks, and prevent friction against the sides of the slots. Springs k'', secured at one end to the hubs of the fingers, and at the other end to a suitable part of the cover, hold the fingers down within the tracks with a yielding pressure. j'' is the handle, pivoted to the top of the cover in rear of the track-fingers, and provided with a weighted extension, j''', which holds it in an upright position by resting upon the cover in rear of the pivot. The front of the handle, near the pivot, is formed with a right-angular projection, as shown in Fig. 26, one arm, j'''', of which extends over the short rear ends of the track-fingers, and, when the handle is swung forward, bears down upon them to raise the points from the tracks of the paper. The other arm, j''''', extends downward, and limits the forward movement of the handle by coming in contact with the cover. If desired, the track-fingers may be connected with the cover in many different ways without departing from the principle of my invention in this regard, which consists in adapting such track-fingers to press upon the embossed tracks of the paper with a yielding action, and to be raised for the insertion of the record in the guide-bed.

b''' is a fixed pin upon the under side of the guide-bed in front of the sleeve, and g''' is a permanent magnetic bar, secured centrally to the lower end of the pin, so as to lie in a horizontal position. b'' is a short horizontal shaft, secured to the under side of the guide-bed to receive the hub b'''' of a pendent arm, C'', and form a bearing, upon which said arm swings from side to side under the guide-bed. The lower end of the arm terminates in a soft-iron ring, g'', through which the magnet g''' projects to limit the lateral swing of the arm. b''''' is a steel or other rack-bar, extending across the top of the hub, with its ends immediately beneath the points of the track-fingers. When the fillet of paper containing the record is moved over the guide-bed, the points of the track-fingers alternately pass down through the slits which form the record, and lie along the embossed tracks, and bear upon the ends of the rack-bar to oscillate the swinging arm C''. c''' c''' are platina hammers, secured to opposite sides of the swinging arm C'', to alternately strike the faces of two platina anvils, g'''' g'''', when the arm is vibrated. The anvils are supported by arms pivoted to opposite sides of the fixed pin b''', being insulated therefrom and from each other. They are also made adjustable by any suitable arrangement of devices. In this instance their inner faces are inclined downward and outward, so that the adjustment may be effected by swinging the arms on their pivots to raise and lower the anvils. Each anvil is connected to the local battery by a separate wire, t^{10}, which passes first through one helix of the reproducing-magnet, then through one helix of the calling-in magnet, and, lastly, through a helix contained in the induction-coil.

y is a bent support secured to the under side of the guide-bed, in front of the vibrating arm C'', and bearing upon the upper side of its arm a platina point, y'. Another like point, y'', is placed opposite the first, upon the under side of the guide-bed, and the two points are properly insulated from each other. y''' is a bent lever, hung to the lower front edge of the guide-bed, in such a manner that the platina hammers on the upper and lower sides of its rear end shall alternately strike the points y' y''. This end of the lever is weighted, so that its lower hammer shall bear upon the lower platina point when at rest. The opposite end extends upward a little above the level of the guide-bed, where it terminates in a scroll or curvature, y'''', over which the record-fillet passes when drawn along by the feed mechanism. The weighted lever is insulated from the guide-bed, and connected by a wire, t^{11}, with that pole of the local battery opposite the pole with which the wires t^{10} of the anvils g'''' g'''' are connected; or, in other words, the wire from the weighted lever is connected with the positive pole of the battery, and the wires from the anvils g'''' g'''' are connected with the negative pole. V'' is a lever, pivoted at K^2 to one of the uprights of the frame above the feed-cylinder E, and carrying at its lower end a horizontal pressure-roller, V', covered with leather or other suitable material. A spring, K^3, attached at one end to the frame, or to the pivot K^2, and bearing with its opposite end upon the lever, holds the pressure-roller against the feed-cylinder with a yielding pressure, so that the teeth or points of the latter shall seize and feed the paper along without danger of its slipping. The spring K^3 is made adjustable by any suitable means to regulate the pressure of the roller against the cylinder. The upper arm of the roller-lever terminates in a finger-piece, adapted to engage with a latch, r r' r''', pivoted to the upright of the frame, for the purpose of holding the pressure-roller out of contact with the feed-cylinder when desired.

When a message is to be transmitted the fillet of paper in which it has been cut by the recording-instrument is placed upon the guide-bed under the cover, and passed to the feed-cylinder over the curved upper end of the weighted lever y'''. The pressure-roller is then let down to hold the paper up against the feed-cylinder, which is in motion, as already explained.

As the fillet of paper is drawn along its tension bears down the curved end of the weighted lever y''', and throws up its inner end, so that the upper platina hammer thereon shall be held in contact with the upper platina point y'' on the guide-bed. The points of the track-fingers, riding along in the embossed tracks of the paper, drop through the slits therein, to alternately press down the ends of the rock-bar b'''', and move the pivoted arm C$''$ to the right and left. The permanent magnet g''' at the end of the pin b''' attracts the soft-iron ring forming the lower end of the arm C$''$, and holds it against recoil or rebound until the arm is again moved by the alternate pressure of the track-fingers. These vibrations of the arm C$''$ carry its hammers c''' c''' alternately in contact with the anvils g'''' g'''', and thus establish a circuit from the positive pole of the local battery, through the weighted lever y''', to one or the other of the wires attached to the anvils, and from these wires through the helices of the recording and calling-in magnets above named; thence through the helices of the induction-coil in the main line, and back to the negative pole of the battery. The vibrations of the arm C$''$, therefore, make and break the circuit through the wires of the anvils g''' g''', and thus alternately reverse the direction of the current induced in the main line; or, in other words, the currents are alternately sent through the helices of the induction-coil in opposite directions, to induce alternately-reversed currents in the main line.

The length of time during which the currents are induced through the main line depends upon the length of the slits in the record, which, of course, retain the track-fingers in contact with the ends of the rack-bar a proportionate length of time. As the signs which constitute the message-symbols are formed by slits of different lengths in the fillet of paper, it follows that the time between the duration of the electric currents induced in the main line will exactly correspond to the distance between the beginning of one slit and the beginning of the next adjoining slit in the opposite row of the record from which they are produced, as above set forth. If, therefore, these induced currents are made to produce other slits in a fillet of paper, such slits will be fac-similes of those in the first fillet or transmitted record. This reproduction of a transmitted record at any of the stations along the telegraph-line forms a succeeding step in my invention, which I will presently describe.

q'' is a curved guide secured to one of the uprights of the frame, beneath the feed-cylinder E, for the purpose of directing the fillet of paper away from the guide-bed, and out of the instrument, after the record has been transmitted.

After the fillet of paper has passed out of the instrument, or ceases to move, the pressure upon the curved end of the weighted lever y''' is relieved, and its weighted end drops down, so that the platina hammer on its under side shall rest upon the platina point y'. This breaks the connection with the upper point y'', and sends the current from the local battery to the receiving-magnet D$'$, through a wire, t^{12}, connecting the oscillating shaft d^2 of such magnet with the lower platina point y'.

Each station on the line is provided with a magnet, by which the message transmitted from another station is received and communicated to the reproducing magnet or instrument. The receiving-magnet is indicated by D$'$ in the drawings, and is composed of two annular covers, O O$'$, of soft iron, mounted one upon the other, so as to inclose two helices, c^8 and c^9, between them, as shown in Fig. 15, one helix being placed within or surrounded by the other. They are wound in the same direction, and insulated from the covers and from each other, while the convolutions of each are also properly separated by insulation.

o^6 and o^7 are, respectively, the outer and inner ends of the outer helix, and o^8 and o^9 are, respectively, the outer and inner ends of the inner helix. The inner helical wire is made considerably shorter than the outer, and therefore possesses only about one-fourth the conducting resistance of the latter, so that when a current is sent through both helices simultaneously, it will contain more magnetic power in proportion to the conducting resistance of the helices than it would if the length of the two helical wires were equal.

The outer end o^6 of the outer helix and the inner end o^9 of the inner helix are connected directly with the main telegraph-wire t^9, as shown in Fig. 31, while the inner end o^7 of the outer helix and the outer end o^8 of the inner helix are adapted to be automatically connected when a message is received and reproduced, but separated when the station to which they belong is not receiving a message, as I will hereinafter describe. d^2 is a rock-shaft, arranged across between the covers, and supported at the ends by knife-edges secured to the lower cover. It is provided with a series of permanent magnetic needles, d^{12}, placed parallel to each other, which are alternately attracted and repelled to oscillate the shaft when the induced current in the main line is sent through the helices c^8 c^9 to magnetize the covers. d^3 is an upright arm, mounted upon the magnetic needles, and carrying a cross-bar at its top.

The ends of the cross-bar are provided with platina hammers d^{14}, which, when the arm is vibrated by the magnetic needles, alternately strike against platina anvils d^4 upon the faces of the collars or rings d^5. These rings are fixed eccentrically to the tops of stems d^7, which, in their turn, are supported in upright tubular bearings or shafts d^6, mounted upon the upper plate O of the magnet. The eccentrics are insulated from the soft-iron covers, and from the tubular bearings, by means of insulating-tubes d^{10} d^{10}, placed around the stems within the bearings, as shown in Fig. 15, so as to hold the lower ends of the stems above and out of contact with the magnet-cover O.

The insulating-tubes are each formed with a flange at its upper end, which holds the eccentric out of contact with the top of the tubular bearings, and therefore insulates one from the other.

Any other method of insulation may be adopted of course, the object being to insulate the eccentrics from the magnet-covers and tubular bearings. By means of the eccentrics the position of the anvils can be adjusted to regulate the throw of the hammers upon the vibrating arm when desired, the eccentrics being held in place by the frictional contact of their stems with the insulating-tubes. The stems of the eccentrics are connected by wires d^8 and d^9 with the anvils g'''' g'''' of the transmitting-instrument, or with the wires of such anvils, as shown in Fig. 31. The wires d^8 and d^9 pass through the sides of the tubular bearings d^6, and are properly insulated therefrom.

When a message is to be received at the designated station, the weighted lever y'''' of the transmitting-instrument rests down upon the platina-point y', which, as hereinbefore stated, is connected by a wire with the shaft d^2 of the receiving-magnet, and the inner and outer helices of the latter are automatically joined, so as to form one long helix interposed in the main line. The induced currents or pulsations of the main line, which constitute the measure of the message-symbols transmitted and the index of those reproduced, are alternately sent through the long helix in opposite directions, to oscillate the shaft d^2 of the receiving-magnet by changing the polarity in its soft-iron covers for each symbol.

The oscillations of the shaft vibrate the upright arm d^3, and carry its platina hammers d^{14} alternately in contact with the platina anvils on the eccentrics d^5. When this contact is effected, the electric current from the positive pole of the local battery passes, through or along the wire t^{12}, Fig. 31, and intermediate devices, to the shaft d^2 and its arm d^3; thence through the eccentrics and stems to the wires d^8 and d^9, and from thence along the wires of the anvils g'''' g'''' through the reproducing and calling-in magnets, and finally through the primary helices of the induction-coil to the negative pole of the battery.

It will thus be seen that the polarity of the receiving-magnet is changed by the reversal of the currents in the main line, while the calling-in and reproducing magnets are worked by the direct or primary current from the local battery. The action of the primary current upon the reproducing-magnet and its devices is continued as long as the contact is maintained between the hammers and their respective anvils in the receiving-magnet, and this contact continues in each case until the shaft d^2 is oscillated by the reversal of the currents in the main line, which, as above described, is effected by the track-fingers of the transmitting-instrument working in the slits of the record being transmitted to vibrate the circuit-changing arm C''.

The duration of the contact between the hammers and anvils of the receiving-magnet, being thus governed by the length of slits in the record transmitted, causes the reproducing devices to remain in action a corresponding length of time, as I will presently show in describing their construction and operation. Therefore, the record from which the message is sent at the transmitting-station will be reproduced in fac-simile at the receiving-station.

The primary helices of the induction-coil are all so wound with respect to such coil that the currents which they induce therein (by the passage through them of the primary current from the local battery) shall be in prolongation of the respective pulsations or currents which send the message. For example, in transmitting a message, one current, forming a symbol, will move along the main wire, say eastward, and the current from the local battery at the receiving-station will pass through the various instruments at that station, and through its proper helix in the induction-coil back to the battery; but its direction through the helix will be such as to induce an eastward current in the main line in prolongation of the symbol-current; and when the symbol-current is reversed, the current in the induction-coil will be also reversed. The winding of the induction-coils and their helices must be, respectively, the same at all the stations of the main line, so that each induced current in such line shall be in the same direction from each induction-coil, to augment and re-enforce the message-currents by the local battery at each station of the line between the transmitting and receiving stations.

D^6 represents the induction-coil interposed in the main wire t^9 t^9, and D^7 D^7 the helices wound therein, one within the other, around a central core, D'''', of soft iron. They are each joined to the local battery, the calling-in and reproducing magnets, as hereinbefore described, and are of such length and size as to produce by one battery an equal amount of magnetism in the core.

The core or magnet of the induction-coil is made in several sections, joined together at the ends, in line with each other, by means of adjusting-screws c^6. This construction enables the sections to be adjusted within the limit of the screws, to regulate the time required for magnetizing and demagnetizing the several sections. In order to increase the quantity of the induced current, additional sections are employed, and the coil increased in length instead of in diameter. This permits the use of thicker wire without increasing the conducting-resistance of the induction-coil as much as would be the case if the coil were increased in diameter instead of in length.

The special advantage arising from the use of a double or compound helix in connection with the induction-coil and one battery is, that it insures uniformity in the force of the currents induced in the main line, and therefore secures the automatic formation of the message-symbols of the requisite relative sizes throughout the whole line; or, in other words, the currents from one battery will be the same in force, whether passed through one or the other helix, and will consequently prevent like message-symbols from differing in length when formed by the passage of the current through either helix.

Two batteries, one for each helix, could not be practically employed, because of the constant liability of the current from one to differ in force from the current from the other, thereby preventing their uniform action, and destroying the possibility of automatically making the message-symbols of the requisite sizes.

If an adjustable resistance-coil were used in connection with an ordinary galvanometer in each circuit, and the resistance adjusted to make the currents equal, the two batteries might work very well at first and for a limited time; but, as the batteries would diminish in force irregularly, the same difficulties, arising from want of uniformity in the force of the two currents, would occur, unless the resistance were constantly adjusted by suitable means.

If but one primary helix should be used in the induction-coil, and the primary current should be broken and closed by one of the platina anvils and hammers, the advantage of using the power of the local battery to demagnetize the iron core in the induction-coil would be lost in the transmission of each message-symbol; or, if a reverser should be substituted so as to be operated by the receiving-magnet, to reverse the primary current of a single primary helix in the induction-coil at each transmission of a message-symbol, there would be an occasional imperfect reversion of the symbol-currents in consequence of the lack of power in the receiving-magnet to work the reverser.

In transmitting a message, the station to which it is sent for reproduction is first "called in"—that is to say, put in communication with the transmitting-station through the main wire. To accomplish this, each station on the telegraph-line is provided with two distinct signals not employed at any other station—to wit, one for throwing the reproducing devices into operation and the other for throwing them out of operation. These signals consist in the repetition of a message-symbol a greater number of times than it is formed consecutively in any one word. For example, the repetition of the letter A four times may be the signal for calling in one station, and the repetition of the letter B four times the signal for calling in another station, and so on. These signals are cut in the record the same as the other message-symbols, but are only effective to control the reproducing devices at the station for which they are designed, or for which they form the index.

When a record or fillet of paper is cut for transmittal to a particular station, the calling-in signal for that station is cut just in front of or before the message, and the signal for throwing out the station, or rather its reproducing devices, is cut in the paper immediately after the message, so that when the record is laid in the guide-bed at the transmitting-station, and the feeding devices set in motion, it will automatically call in the proper receiving-station, transmit the message thereto, and then throw its reproducing devices out of operation.

The mechanism for calling in a station and for the reproduction of a message thereat is constructed as follows: D″ is the magnet of the reproducing devices, and D‴ the calling-in magnet. The latter is arranged under the frame of the instrument, in line with the registering-wheel, and the former has a special arrangement, as I will presently show. These magnets are each composed of two soft-iron annular covers, O O′, inclosing two helices wound one within the other, and of oscillating cross-shafts carrying permanent magnet-needles, the construction in these several respects being the same as the receiving-magnet D′.

The outer ends of the two helices in the magnet D″ are respectively joined to the wires of the anvils g'''' g'''' in the transmitting mechanism, while the inner end of the outer helix and the inner end of the inner helix are joined respectively to the outer ends of the two helices in the magnet D‴. The inner ends of these latter helices are connected respectively with the two primary helices in the induction-coil, as shown in Fig. 31. The winding of the corresponding helices in the magnets D″ D‴, as well as in the receiving-magnet D′, must be in the same direction at all stations, in order to maintain the same direction for each current throughout the line. d^{13} d^{13} are upright arms mounted upon the parallel needles of the calling-in magnet D''', upon opposite sides of the cross-shaft, so as to extend upward through an opening in the bottom of the frame, as shown in Fig. 2. The upper ends of the arms are united at the top by a cross-bar, m^2, the ends of which carry metallic plates m^3, having faces inclined toward each other from opposite sides of a registering pin wheel, E'', as shown in Figs. 8 and 10.

When the primary current from the local battery is alternately sent through the helices of the calling-in magnet, it oscillates the shaft thereof by the magnetism of the soft-iron covers, and therefore vibrates the plates m^3 to alternately strike the ends of the pins and drive them through the wheel. This wheel is firmly keyed to a counter-shaft, E''', having its bearings in the two front uprights of the frame, beneath the driving-shaft B, and parallel therewith. The counter-shaft E''' is provided with friction-wheels u, which support the driving-shaft B, and therefore communicate its motion to such counter-shaft. Any other convenient means may be employed for driving the counter-shaft from the shaft B, but I prefer the friction-wheels, as being the most simple and affording the minimum amount of friction.

The wheel E'' is constructed with a grooved periphery, and through the parallel flanges thereby formed at the edges are passed a series of transverse pins, m^4, so as to move freely from side to side. The pins lie parallel to each other and form a row entirely around the wheel, with their ends projecting a little beyond the faces of the latter.

m^7 is a band, passing around the wheel between the flanges, and bearing upon the pins to keep them in place, save at the bottom of the wheel, where the pins receive upon their ends the action of the inclined plates m^3. At this point the band extends below the wheel around a pulley, m^8, and the pins are thus relieved from its pressure. The pulley is mounted upon a spring, q^5, secured to the frame of the instrument under the wheel, and adapted for adjustment by any suitable means to regulate the tension of the holding-band. The pulley and spring are arranged slightly in rear of the wheel, as shown in Figs. 1 and 8.

m^5 and m^6 are two sleeves, mounted loosely upon the shaft E''', one on each side of the wheel, and provided with radial arms m^9, projecting to the front and rear of the shaft upon opposite sides of the wheel. Two frames, n^2 and n^3, are mounted, one upon each of these arms, so as to move freely toward and from the sleeves. They are constructed substantially alike, and for this reason it is only necessary to give a detailed description of one in order to a full understanding of both.

The frame n^2, which is the one I have selected for description, is composed of the following parts, to wit: nearest the sleeve is a segmental brace or guide, n^4, fitted upon the radial arm m^9, and carrying at its ends two radial diverging arms, n^5, which extend to the periphery of the wheel, and are there secured to one edge of a slotted segmental strip or plate, n^6. This plate lies in a plane at right angles to the diverging arms, and extends laterally over the wheel, so that the latter shall project slightly through its slot, as shown, the lower end of the frame being curved or bent outward, to prevent it from coming in contact with the band when moved forward with the wheel. The inner proximate edges of the slot are formed with several projections, n^{10}, which are held down upon the ends of the pins upon each side of the wheel by the tension of a flat spring, n^8, connecting the two diverging arms of the frame, and secured centrally to the radial arm m^9 of the sleeve. The frames are thus supported upon and by the pins with a yielding pressure, so that the wheel shall revolve and carry the pins out from under the projections without moving the frames. The frames thus remain stationary while the wheel revolves until such times as the projections are locked to the pins for the purpose of moving the frames. The projections n^{10} are not arranged directly opposite each other across the slots, but the spaces in one edge are opposite to and receive the projections in the other edge.

The frame n^2 is employed for calling a station into the main line to receive and reproduce a message, and the frame n^3 is employed to throw the station out of communication with the transmitting-station when the message has been sent. The frame n^2, therefore, is the medium to be influenced by the calling-in symbols cut in the record immediately preceding the message to be transmitted, and the frame n^3 is the medium to be influenced by the throwing-out symbols cut in the record immediately after the message.

When it is desired to call in a station for the reception and reproduction of a message, the signals for such station are first transmitted and actuate the receiving-magnet at the receiving-station, so as to send the primary current from the local battery through the calling-in and reproducing magnets. The vibratory changes of the track-fingers at the transmitting-station change the polarity of the several magnets at the receiving-station, as already explained, to oscillate their respective cross-shafts. This oscillation of the cross-shaft in the calling-in magnet vibrates the upright arms d^{13}, and causes the inclined plates m^3 thereon to alternately strike the ends of the pins in the revolving wheel E'' and move them through the flanges in opposite directions. The pins are therefore set by the calling-in signals, and when the wheel has revolved far enough to bring the set pins around to the frame n^2 they will not lie under the projections n^{10}, but within the spaces between them. The projections being thus removed from under the pins the tension of the spring n^8 pulls the frame n^2 toward the sleeve m^6, within the path of the set pins, so that the latter shall bear against the notched lower edges of the projections n^{10}, when the wheel revolves in the direction of the arrow, Fig. 8, and carry the frame n^2 with them about two-fifths of a revolution of the wheel. It is then again moved out from the sleeve and remains stationary outside the pins of the moving wheel, until is carried back by suitable means to the point from whence it started. This backward movement takes place only after the message has been received and reproduced, and the frame n^3 is being moved by the throwing-out signals.

In the frame n^3 the upper edges of the projections n^{10} are notched, instead of the lower edges, as in the frame n^2, and the arrangement of the notches is necessarily different in the two frames, in order to indicate different signals.

The configuration of the projections in each frame of a station must correspond to the calling-in and throwing-out signals which represent that station. For example, if the repetition of the symbol for letter A four times is the signal for a station, then the outlines described by the projections of its frames must be the same as the outlines described by the pins m^4 under the impulses of the reciprocating setting-plates m^3, induced, continued, and governed by such repetitions of the symbol. When, therefore, the wheel at the receiving-station revolves so that the outlines of the pins coincide with those formed by the projections on one or the other of the frames, the latter will be drawn toward the sleeve to engage with the pins, as above described.

The throwing-out signal may be the same as the calling-in signal of the same station; but if the latter is the repetition of a letter several times—say, A, four times—then it would perhaps be preferable to increase the number of repetitions for the former, say, A, five times; but I prefer to employ a different letter for the throwing-out signal.

Each station must have its separate signal, and its frames must be made to correspond therewith, so that the signal from one station shall never operate or otherwise affect the frame at another station, and each station is provided with the signals for all the others.

Since, however, in transmitting a message from one station, all the magnets at all the other stations of the line are affected by the change in the direction of the transmitting-current, it follows that the pins m^4 at every station, including that which transmits the message, will be displaced by the reciprocations of the plates m^3, but that only the frame n^2 at the called station will be affected to set the reproducing mechanism in motion.

To restore the alignment of the pins with their ends in the same plane upon opposite sides of the wheel, two beveled uprights, q^2, are secured to a plate, E′, on the bed of the instrument, and rise upon each side of the wheel adjoining the path of the pins.

The plate E′ is fastened to the bed of the frame in front of the tension-roller m^8, and holds the uprights in rear of the reciprocating setting-plates m^3 on the arms of the calling-in magnet, so that the rotation of the wheel shall carry the pins between the uprights before receiving the action of the plates.

The uprights are beveled from the rear inward toward the wheel, the widest space between them being a little greater than the whole space occupied by the pins when driven to the right and left, and the narrowest space just sufficient to allow the passage of the pins between them when their ends are in line each side of the wheel. When, therefore, the pins have been moved by the setting-plates, the wheel carries them round to the beveled uprights q^2, by which they are again ranged in line with each other preparatory to the next action of the plates. Thus the pins are aligned at each revolution of the wheel at every station.

There is a liability that the action of the setting-plates will drive the pins too far through the wheel to properly register with the frames, and, to prevent this, two other beveled uprights, q^3, are employed, rising from the bed of the instrument, or from the plate E′, upon opposite sides of the wheel in front of the setting-plates, as shown in Figs. 8 and 10. They are placed farther apart than the uprights q^2, but are beveled in the same direction, their inner edges being separated just far enough to permit the passage of the pins when set to the proper point. If, however, the pins are driven too far by the setting-plates, they will strike the beveled faces of the uprights, and be moved back thereby through the wheel into the proper position for registering with the frames.

In case the uprights q^2 and q^3 are mounted upon the plate E′, the latter should be slotted for the passage and movement of the vibrating arms d^{13}, which carry the setting-plates.

The calling-in frame n^2 is so arranged that its lower diverging arm n^5 shall stand at a point, n^9, at the front of the wheel. It therefore starts from this point when drawn toward the sleeve m^5 to engage with the pins m^4, and moves forward with the sleeve and wheel until its upper diverging arm n^5 reaches a point, p^2, at the top of the wheel, when it is disconnected from and thrown outside of the pins by the following mechanism, there to remain until the message has been received and reproduced.

p^4 is a rod secured at one end to the segmental brace n^4 of the frame, from which it extends to a collar, o^2, formed upon the outer end of the sleeve m^5. Its outer end fits within a radial slot of the collar, so as to work freely toward and from the sleeve with the movements of the frame.

When the frame n^2 is moving forward with the wheel, and just before its upper diverging arm reaches the limit p^2 of its throw, the point of an upright cam or arm, p^5, secured to the bed of the instrument, so as to curve from the rear over the top of the sleeve m^5, passes between the latter and the rod p^4, as shown in Fig. 13 of the drawings. The rod then rides along the outer edge of the cam, and is moved by its increasing width outward from the sleeve until the frame n^2 reaches the point p^2, when it is entirely disconnected from and thrown outside of the engaging pins, and ceases to move with the wheel. The cam holds the projections of the frame out of contact with the pins, to prevent the wear of these parts by friction, and to guard against their casual movement by catching into each other.

The throwing-out frame n^3 is also connected by a rod, p^4, to a collar, o^3, at the end of the sleeve m^6, and being arranged in rear of the shaft E''', starts from a point, n^9, at the under side of the wheel, when drawn toward the sleeve, to engage the set pins. It stands with its upper diverging arm n^5 at the point n^9, and its forward movement with the wheel terminates when the lower diverging arm n^5 reaches a point, p^3, at the back of the wheel. At p^3 the frame n^3 is thrown outside of, and held out of contact with, the engaging pins, and ceases to move with the wheel, by means of an upright pointed cam, p^7, mounted upon the bed of the instrument, as shown in Fig. 12, the operation being the same as the operation of the frame n^2.

p^6 and p^8 are angular levers, pivoted at their angles to the sides of the upright cams p^5 and p^7, respectively. They are arranged in opposite directions, so that their upper ends shall lie one in front of the sleeve m^5 and the other in rear of the sleeve m^6. Their lower ends are weighted, and provided with adjusting-screws n^{12}, which are adapted to rest upon bearing-surfaces n^{13}, formed upon extensions of the upright pointed cams, as shown in Figs. 12 and 13.

When the throwing-out frame stands at its highest point upon the wheel, out of contact with the pins, the front side of the bar p^4 rests upon the upper end of the lever p^8 to lock the frame against forward movement until it is drawn toward the sleeve. When this takes place the bar also moves inward and clears the end of the lever, thereby releasing the frame, so that it can move forward with the wheel to the point p^3, as above described.

The upper end of the lever p^6, in order to lock the calling-in frame n^2, passes up in front of the bar p^4, and is notched or recessed to fit over such bar when the frame is at its lowest point upon the wheel, out of contact with the pins. The catch-lever thus locks the frame against any forward movement until the throwing-out signal for the station is received, when the bar p^4 moves inward to clear the end of the lever and release the frame, so that it may move forward with the wheel the same as the frame n^3.

The upper ends of the two locking-levers are prevented from moving with, or following, the bars p^4 inward, by means of the adjusting-screws n^{12}, which screws also serve to regulate the distance between the levers and sleeves for the passage of the frame-bars p^4. The frames are arranged to move forward with the wheel at different times, and to move back against its revolution, one after the other—that is to say, when the calling-in frame is moving forward with the wheel the throwing-out frame is riding back clear of the pins, and when the throwing-out frame is moving forward the calling-in frame is moving back to its normal position.

The mechanism for moving the frames back consists of two arms, o^4 o^4, secured, respectively, to the outer ends of the sleeves m^5 and m^6, so as to extend downward through slots in the bed of the instrument, where they are pivoted by rods o^5 to the extremities of a long lever or working-beam, o^{16}, hung at its center to the rear under side of the bed. When, therefore, the movement of either frame operates its supporting-sleeve, the working-beam, through its connecting parts, will move the sleeve of the other frame in the opposite direction.

For the purpose of securing accuracy and certainty in the operation of the frames, the movements of the working-beam are sharpened and quickened by the action of a jointed spring-lever in the following manner: r^2 is the lever, secured at its rear end r^4 to the instrument, and extending forward to connect with one arm of the working-beam by a short pivoted rod, q^8. A spring, q^9, secured to the bed of the instrument, forces the lever toward the connecting-rod, and when the oscillations of the working-beam carry its arm in front and rear of the joint formed by the lever and rod, the spring acts to throw it quickly against the front or rear stop-pins r^5 r^6, which limit the sweep of the beam, as shown in Fig. 3.

The reproducing devices are constructed and operate as follows: l' is a guide-bed, secured to a tubular bearing, O'''', which fits upon an upright shaft, O''''', at the rear of the instrument, so as to hold the guide-bed in line with the feed-cylinder D. The upright shaft is insulated from the main frame, and the guide-bed, in its general features, is constructed the same as the guide-bed of the transmitting devices—to wit, with an adjustable gage side, l'', an adjustable spring pressure-bar, z''', and a weighted cover or pressure-piece, l''', having a handle, z'', and adapted to operate the sliding cross-bars z'''', when swung open, and to bear upon the point of an adjusting-screw, z''''', in the bed, when closed.

c^6 is a shelf or arm, attached by a sleeve, c^{10}, to the tubular bearing of the guide-bed, and extending forward under the latter, to support the reproducing-magnet D'', as shown in Fig. 18. A short arm, c^{13}, projecting from the tubular bearing, carries a set-screw, c^{12}, which enters a corresponding arm, c^{14}, of the sleeve, to support the shelf and regulate the position of the magnet-knives with respect to the guide-bed. c^7 is a flat spring, connecting the shelf with an adjustable holder upon one of the uprights of the frame, to permit a slight lateral swing of the guide-bed and magnet, for the purpose of compensating for any irregularities in the movements of the paper fillet over the guide-bed.

a^4 are blocks mounted upon the permanent magnetic needles of the magnet D″, upon opposite sides of the rock-shaft, to limit the oscillations of the latter by contact with the covers O O′, and support the pivoted upright arms a^{12}.

b^6 are guide-blocks secured to the front end of the bed, in continuation thereof, and grooved vertically, to receive the upper ends of the arms a^{12}, which are curved or bent so as to stand parallel to each other within the grooves. The upper ends of the arms are also slotted for the passage of pins b^7, which extend through the blocks, to guide the movements of the arms.

b^4 b^4 are pointed reversible slitting-knives, adjustably attached to the arms a^{12} by means of the slotted blocks and set-screws b^2, so that their points shall project through the grooves in the guide-blocks above the upper surface of the bed, when the arms are reciprocated by the oscillations of the needles in the magnet D″. The cutting-edges of the knives stand at the rear, next the guide-bed, so as to slit the fillet of paper as it is drawn along by the cylinder.

b^8 b^8 are guide-blocks, secured to the cover of the guide-bed by means of set-screws b^{18}, so that their slots shall register with the slots in the guide-blocks b^6. Each block b^8 carries an embossing-roller or styles b^9, to bear down, under the weight of the cover, upon the fillet of paper as it passes over the bed, and form parallel grooves therein by pressing it into the grooves of the lower blocks b^8. The rollers also expand or widen the slits in the record. The guide-blocks b^6 are properly grooved for this purpose, such grooves being the requisite distance apart to register with the grooves in the feed-cylinder D and the grooves of the transmitting devices. Any preferred design may be given to the embossed tracks in the paper by giving a corresponding form to the grooves in the guide-blocks b^8, or to the periphery of the embossing-rollers.

India-rubber blocks c^3 are secured within the guide-blocks b^8, to bear down upon the points of the slitting-knives and insure their cutting, such bearing-blocks being adjusted by set-screws b^4.

V is a pressure-roller covered with leather or other elastic material, and mounted upon the lower end of a lever, V‴, so as to hold the fillet of paper in contact with the front side of the feed-cylinder D, when the paper is being drawn forward. The lever is pivoted centrally to one of the uprights of the frame, and carries one end of an adjustable spring, K⁗, the other end of which is secured to the pivot, the purpose of such spring being to bear the pressure-roller against the feed-cylinder. The upper end of the lever terminates in a finger-piece, J″, by pressing upon which the roller V is removed from contact with the feed-cylinder, in which position it may be held, when desired, by any convenient locking device.

q^6 is a lever hung at q^7 to the upright of the frame, beneath the feed-cylinder, with its upper end lying against the inner side of a pin projecting from the end of the pressure-roller V, and its lower end against a cam, o^{20}, mounted upon the sleeve m^5 of the calling-in frame. The form and position of this cam upon the sleeve are such as to throw the upper end of the lever q^6 forward, and hold the pressure-roller V out of contact with the feed-cylinder when the paper fillet is not in operation over the reciprocating slitting-knives. The reproducing mechanism is made ready for operation to reproduce a message, by laying a plain uncut fillet of paper upon the guide-bed, under the weighted cover, passing over the feed-cylinder D downward behind the pressure-roller.

When the signal for calling in the station causes the calling-in frame n^2 to move forward with the registering-wheel, the sleeve m^5 moves with it, as already described, and carries the short radius of the cam o^{20} against the lower end of the lever q^6. This releases the pressure-roller V, so that its spring K⁗ shall bear the fillet of paper against the feed-cylinder D to be fed forward. As already explained, the induced or message currents of the main line operate the receiving-magnet, while corresponding currents, direct from the local battery of a station, operate the calling-in and reproducing magnets at every change in the message-currents. When, therefore, the polarity of the reproducing-magnet is changed, the slitting-knives are alternately reciprocated through the moving paper to form the slits therein. The length of such slits corresponds to the period of time each knife is held upward, while the paper is moving at a uniform rate of speed, and the duration of their respective upward throws ceases only with the changes of the track-fingers in the transmitting-instrument. It, therefore, follows that the slits reproduced in the fillet of paper at the receiving-station will be fac-similes of those forming the record at the transmitting-station, provided the fillets of paper move at the same speed. The method of effecting a uniform movement of the paper at all the stations I will presently describe. The calling-in frame of the receiving-station is held forward upon the registering-wheel until all the message has been received and the throwing-out frame brought into action, when it moves back upon the wheel, so that the cam o^{20} shall again operate the lever q^6 to throw the pressure-roller V out of contact with the feed-cylinder, and stop the further movement of the paper until the station is called in again. a^6 is a curved guide secured to one of the uprights of the frame, beneath the feed-cylinder, for directing the fillet of paper out of the instrument, and a^8 a^9 are the blades of a pair of shears for cutting off the paper after it has left the cylinder. The upper end of the curved guide is formed with a loop to direct the paper down between the blades, which occupy a horizontal position just under its lower edge. The lower blade a^9 is attached to the upright of the frame, and the upper movable blade a^8 is attached to an upright rod, p, so as to work over the edge of the fixed blade. The rod p is held in a vertical position against an adjoining upright of the frame by suitable guides, and is formed with a crank or handle at its upper end, by which it is operated to swing the blade a^8 inward in contact with the fixed blade and cut off the fillet of paper. Its lower end is surrounded by a coiled spring, p', one end of which is made fast thereto, and the other end is secured to the bed of the instrument. The tension of this spring is such as to throw open the blades of the shears after the rod p has been released, and to press the swinging blade down upon the fixed blade, for the purpose of insuring the proper cutting action.

The fixed blade occupies a position against a shoulder formed in the curved guide, as shown in Fig. 23, or is otherwise connected to the latter in such a manner that its cutting-edge shall lie behind the plane of the guide, out of the path of the paper from which the strip or record has been cut. By this provision the end of the paper is prevented from catching on the blades of the shears or flying out of the guide-loop after the record is cut off.

When a message is being received and reproduced at a station the two helices of the receiving-magnet are automatically connected to form one helix for the purpose of increasing the power of the magnet to effect the changes in the polarity of the reproducing-magnet. When the station is not receiving a message the helices of its receiving-magnet are disconnected and joined separately to the main line for the purpose of offering less resistance to the passage of the line-current through them. Therefore the power of a receiving-magnet is increased when receiving a message by the decrease of conducting resistance in the receiving-magnets of all the other stations within reach of the line-current.

The mechanism for automatically connecting and disconnecting the two helices is constructed and operates as follows: R^1 R^2 R^3 are three bent levers pivoted to a corresponding number of uprights secured to the frame of the instrument, being insulated therefrom, and arranged in front of and below the sleeve m^6. The front ends of the levers are weighted and provided each with a platina hammer to rest down upon corresponding platina anvils in the standards, while their rear ends terminate within the path of a series of cams, r^{10}, secured by an insulating-strip, r^9, to the sleeve m^6, as shown in Fig. 2. The outer end o^8 of the inner helix in the receiving-magnet is bifurcated or branched to connect with the anvils of standards R^1 and R^2, and the inner end o^9 of such helix, after joining the wire t^9 of the main line, connects with the anvil of the standard R^3. The inner end o^7 of the outer helix is branched to connect with the hammers of the levers R^2 and R^3, and the outer end o^6 of such helix, after joining the main wire t^9, connects with the anvil in lever R^1. The inner ends of the weighted levers are so curved or provided with projections that when a station is called in to receive a message and the sleeve, m^6, rotates forward with the calling-in frame the cams r^{10} will raise the hammers of levers R^1 and R^3 and permit the hammer of the lever R^2 to rest down upon its anvil. This forms a connection between the inner end of the outer helix and the outer end of the inner helix, and makes of them a continuous helix during all the time a message is being received and reproduced. After the message has been received and the receiving-station thrown out of communication with the transmitting station the cams operate to raise the hammer R^2 and permit the hammers R^1 and R^3 to drop down upon their respective anvils. The two helices are thus separated, so that the current of the main line shall pass through both simultaneously.

A fourth platina anvil and lever-hammer, R^4, are arranged beside the others, and interposed in the wire t^{11}, which connects the local battery with the curved lever y''' of the transmitting devices, one end of the wire being connected to the hammer, and the other end to the anvil.

The function of these devices is to notify the transmitting-station that the receiving-station has been called in, and is ready to receive the message. For this purpose the rear end of the lever is notched to form one or more teeth, so that when the sleeve m^6 moves forward, as above described, one of its cams, r^{10}, will strike the teeth, and then fall into the notches behind them. When in contact with a tooth, it presses down the rear end of the lever, and raises the hammer at the front end out of contact with the anvil, to break the circuit between the local battery and the lever y'''; and when it passes into the notches the hammer is released, and drops down upon the anvil to make the circuit. By this means the circuit is rapidly made and broken, one or more times in succession, according to the number of teeth and notches in the lever, and the result is that, when the circuit is made, the current from the local battery of such receiving-station passes through the calling-in magnet, the reproducing-magnet, and the helices of the induction-coil, back to the opposite pole of the battery, as already explained, thereby inducing a current in the main line at the receiving-station. The effect of this induced current is to oscillate the upright arms of the receiving-magnet back at the transmitting-station, and so assure the operator there that the receiving-station is called in ready to receive the message. After these preliminary signal-changes in the circuit of the local battery at the receiving-station the contact of the hammer and anvil is necessarily continued while the message is being received, and when the station is thrown out.

To establish a uniform movement of the fillets of paper at all the stations of a line, the driving-shafts B are adjusted to the same speed, which is measured by the vibrations of a pendulum at each station in the following manner: f^6 is a wide metal bar, pivoted at its lower end to one of the legs of the instrument under or near the transmitting devices, and slotted at its upper end for the passage of a set-screw, f^8, by which it may be adjusted to the right or left. f^2 is the pendulum, hung from the bottom piece of the frame, but insulated therefrom, so that the flat piece g^7 at the lower edge of the weight shall alternately strike the upright points of a crescent-shaped metal trip-plate, g^3, when the pendulum is vibrated. The trip-plate is secured to a long sleeve, g^2, mounted upon a front-projecting pin of the upright bar. The inner end of the sleeve carries an upright platina-faced arm, g^4, which is thrown alternately to the right and left against platina-faced stop-pins g^5, when the pendulum is vibrated to oscillate the trip-plate and its sleeve. The stop-pins are secured to the upright bar upon opposite sides of the sleeve, being properly insulated from the bar, and are connected, respectively, by the wires d^8 and d^9, to the wires t^{10}, which join the anvils of the transmitting devices to the helices of the reproducing-magnet. The upright bar is insulated from the frame, and the trip-plate is insulated from the bar by suitable means. h^2 is a weighted right-angular finger-piece, hung upon the pivot f^5 of the pendulum, so that its weighted end shall extend within the space formed between the bottom of the frame A and an angular arm, h^5, secured thereto, as shown in Fig. 1. The upper and lower sides of the finger-piece are provided with a platina point or hammer, h^4, to bear alternately against corresponding points or anvils h^6 in the frame and arm. Its normal position holds the two lower points in contact, and disconnects the two upper points.

The wires t^{11} and t^{12} from the local battery connect the lower point in the arm h^5 with the rock-shaft of the receiving-magnet D′, and a wire, t^{13}, connects the upper point in the frame with the crescent-shaped trip-plate. To form the circuit from the battery to the trip-plate, the lever y''' of the transmitting devices being down upon its lower anvil, the operator presses his finger upon the weighted finger-piece, so as to raise the weighted end in contact with the wire t^{13}, and lift it from contact with the wire of the receiving-magnet. This throws the latter out of the circuit and sends the current from the battery along the sleeve of the trip-plate to its arm g^4. The pendulum, being next set in motion by the operator, will vibrate quite a number of times to oscillate the arm g^4 against the stop-pins and send the current alternately through the wires d^8 t^{10} and d^9 t^{10}, to reciprocate the slitting-knives of the reproducing-magnet.

The length of time the knives are held projected through a moving fillet of paper depends upon the length of the pendulum vibrations, while the length of the slits depends upon the speed of the paper through which the knives are held. If, therefore, the vibrations are known, the speed of the paper can be readily ascertained to determine the length of the slits. For example, if the instruments of the line, when made and put up, are adjusted to run off two feet of paper at every four beats or half-vibrations of the pendulum, and it is desired to change the movement of the paper to one foot per second, the operator adjusts the speed of the driving-shaft so that it shall feed the paper three inches for every beat of the pendulum. If the paper is to be moved four feet per second, the operator adjusts the speed of the shaft to feed one foot for every beat of the pendulum.

The method of determining when the paper is moving at the requisite speed is to measure the slits produced at every beat of the pendulum.

All the pendulums of the line are made alike, so that their vibrations shall be equal, and thereby furnish a standard measure of time at all the stations. If any change is required in the speed of the paper, all the stations are notified from the main office and the required change specified. The operators then regulate the speed according to the beats of the pendulum, as above described. By this means the paper at all the stations is made to move at the same speed to transmit and reproduce fac-simile records.

g^9 is a horizontal arm, attached to the frame A near the pendulum, and g^8 is a long thin spring, connecting its outer end to the oscillating arm g^4, to prevent the recoil of such arm when thrown against the stop-pins by the pendulum. The holding-arm g^9 is adapted for adjustment by any suitable means to regulate the tension of the spring.

The set-screw f^7, which secures the upright bar f^6 in place, also permits the lateral adjustment of the bar to hold the vertical axis of the pendulum, when at rest, in line with the center of oscillation of the trip-plate, for the purpose of preventing the arm g^4 from striking one stop-pin sooner than the other when the pendulum vibrates. This equalization in the deflection of the bar g^4 from the vertical line of the pendulum insures uniformity in the length of the slits by which the required speed of the paper is ascertained. Without it the length of the slits would be unequal, and could not afford a correct guide for the purpose.

In order to prevent atmospheric electricity upon the main wire from passing through the receiving-magnet of a station to burn the helices or otherwise injure the instrument, a lightning-arrester, Z^1, (shown in Figs. 30 and 31,) is interposed in opposite ends of the main wire as it enters the magnet from each side of the station. They are each composed of two grooved half-cylinders of metal, clamped together upon a piece of fine insulated wire, Z^2, placed in the main wire, and the outside of each cylinder is joined, by a large wire, Z^3, to the opposite end of the main wire beyond the opposite cylinder, so as to conduct a strong atmospheric current along the main line past the station, without permitting it to enter and burn the fine wire of the receiving-magnet.

The insulation of the wires Z^2 is sufficient to direct the induced message-currents into the helices of the receiving-magnet, and prevent them from passing the station through the arresters; but this insulation is entirely overcome by the strength of the atmospheric currents, which, therefore, pass the station without the liability of injuring the instruments, as above stated.

The ends of each wire Z^3 are joined to a helix, Z^4, and the helices are arranged one within the other, in the same manner as those heretofore described. Z^5 is a magnetic needle pivoted to a dial-plate placed within the axial aperture of the helices. The needle stands at a certain predetermined point upon the dial when the insulation of the wires Z^2 is perfect and the line in working order; but when the insulation becomes defective from any cause the needle will be deflected to the right or left by the escape of the message-current through one or the other of the lightning-arresters. The extent of the deflection shows upon the dial the extent of the defect, and indicates the needed repairs.

Z^6 are switches pivoted to suitable insulated supports between the ends of each wire Z^3 as they join the helical wires. (Shown clearly in Fig. 31.) The switches, when turned to connect both branches or ends of a wire, cut off the current from the helices; but when turned out of contact with such branches allow the current to pass through the helices. They are usually arranged to keep the currents cut off, and are only turned to let them pass through the helices when the insulation is to be tested by the magnetic needle and dial. This, however, is not absolutely necessary, because they may or may not stand normally cut off, as preferred or found most desirable.

X^1 is an adjustable resistance-coil provided with an index-finger and dial, and inserted in the local line, as shown in Fig. 31. The object of this arrangement is to enable the operator to graduate the conducting-resistance in the local circuit, so that the surplus power of the battery may be utilized and the working force of the battery kept the same during the latter part of its use as when the battery is first put up. The deflection of the index-finger upon the dial shows the amount of resistance. When the power of the battery is great, the resistance is made proportionally great, and as the power decreases the resistance is also decreased, until no surplus power exists, thereby maintaining a uniform working power.

To determine the amount of battery-power, an ordinary galvanometer, X^2, is connected to the resistance-coil X^1, so as to form a part of the local circuit, as shown in Figs. 5 and 31.

By means of the resistance-coil the operator is enabled to adjust the conducting-resistance in the local circuit, so that the needle of the galvanometer will be deflected to a point on its dial that indicates sufficient power of the battery to produce induced currents along the main line suitable for the automatic transmission of messages.

When it desired to cut out the induction-coil at a station, for the purpose of adjusting the movements of the paper by the pendulum, a pivoted switch, Z^7, is inserted in the wire of the induction-coil between its commencing and terminating ends, as shown in Fig. 5, or by inserting it in a branch wire, Z^8, connecting such ends, as shown in Fig. 31.

When a transmitted message has been automatically received and reproduced at the terminal station of a line, and it is desired to farther transmit it over a succeeding line, the reproduced record-fillet is placed in the transmitting-instrument of the succeeding line, and the message automatically sent either to the end of such line, or to an intermediate station thereon, for delivery. If sent to the end of the line it may be again automatically reproduced and transmitted over another line, and so on throughout the entire route. Thus, in sending a message, it is automatically reproduced at the end of a line for automatic transmission over the next line, without the delays and consequent waste of time and labor necessary to reprepare a message at the end of each line, as at present practiced with all automatic telegraphs.

The instruments of the different and independent lines are regulated and adjusted to operate in harmony with each other, so that an original or a reproduced record-fillet of one line can be used equally well to automatically operate all the other lines.

At the delivery-station the record-fillet containing the reproduced message is employed, in connection with suitable mechanism independent of the line, to automatically produce a dispatch for delivery, printed in ordinary typographic characters. This constitutes the last step in my system and process. The mechanism which I preferably employ for this purpose is constructed and operates in the following manner:

In the accompanying drawings, A is an upright, mounted upon a suitable frame, and supporting a cross-shaft, C, near its top, which shaft carries a grooved driving pulley, D, at its outer end, and a serrated or toothed feed-cylinder, B, at its inner end.

F is a pressure-roller, hung upon the lower end of a bent arm, G, pivoted to the side of the upright, and supporting the pressure-roller, just in front of the feed-cylinder. A spring, h'', attached to the upright, exerts its tension against the arm G, and bears the roller against the feed-cylinder with a yielding pressure, which may be regulated by making the spring adjustable in any convenient manner.

The pressure-roller insures the feed of the paper containing the message-slits by holding it against the sharp teeth of the feed-cylinder, and it is formed or covered with leather or other yielding substance, which shall receive the impress of the teeth, and prevent the paper from slipping. The roller is further made with two parallel peripheral grooves, a', at the proper distance apart, to receive the parallel embossed tracks in the paper fillet containing the message-slits.

The upper end of the roller-arm G forms a finger-piece, H, which, when the arm is moved back to carry the roller out of contact with the feed-cylinder, is caught by a latch, I, pivoted to the top of the upright. The latch is also formed with a finger-piece, and its forward end is beveled in front of the pivot K, to receive the action of a spring, L, by which it is held engaged with the roller-arm, as shown in Fig. 3.

N is a horizontal guide-bed, arranged in rear of and in line with the feed-cylinder, for the pupose of directing the message-fillet q' thereto, and to afford support for the mechanism by which the slits in such record are made to control the movements of the type-wheel in producing a printed message. The guide-bed is supported in position by means of a sleeve, n'', fastened to its under side and fitted over an upright shaft or spindle, l'', secured to the main frame.

The lower end of the sleeve is provided with a front-projecting arm, o'', which is connected by a coiled spring, p''''', to a friction or other adjusting-pin, q'', in the side of the upright A. This connection allows the bed a slight lateral swing to compensate for any irregularities in the running of the paper to the feed-cylinder, the holding-spring yielding readily for this purpose when the paper presses against the side of the bed.

r''''' is a stop secured to the frame of the instrument within the path of the sleeve-arm o'', and formed with two shoulders, between which the end of the arm works to limit the swing of the bed.

The top surface of the guide-bed, for about half its width, and for a certain distance in front of the supporting-sleeve, is arched or made convex, and slotted longitudinally for the passage of two parallel gage-fingers, h', which are mounted upon a shaft, j', held in hangers k' l', upon the under side of the bed. The shaft forms the center of the arc described by the raised surface of the bed, and the fingers radiate from the shaft so as to move through the slots in the arch with their points projecting slightly above the same. k'' k'' are parallel V-shaped ribs or rails secured to the bed in front and rear of the arch, and in line with the slots therein, such slots and ribs being the same distance apart as the grooves in the pressure-roller. S$''$ is a gage side arranged at the inner edge of the guide-bed, and composed of a band or strip which curves over the arch and forms deep guides at the front and rear thereof. It is held in place by set-screws n''', which are adjusted to regulate the position of the gage side, for the purpose of properly guiding the fillet q with its tracks upon the ribs of the bed. The opposite or pressure side of the bed is composed of a strip, u'', having a series of projections, y'', upon its face, and set into a wide groove formed lengthwise in the bed. It is held up near or against the side of the arch, so that its projections shall bear against the fillet of paper by means of the bent spring C$''$, placed behind it and secured to a block, O, at or near the outer edge of the bed. The block is slotted for the passage of a set-screw, by which it is adapted for adjustment to regulate the position of the guide and its pressure against the paper. t'' is the cover hinged to the outer edge of the bed, and formed with a slotted concavity, terminating at each end in parallel grooves to fit upon the arch and ribs of the bed beneath. The gage-fingers extend into the slots of the concavity to prevent the paper from slipping off their ends when in motion. The hinges are composed of lateral arms g''', at the ends of the cover, hung upon pintles h''', formed upon blocks a'' secured to the outer edge of the bed. The ends of the pressure-bar are provided with loops w'' w'', which extend around the pintles of the hinges, and rest upon the bed, so as to guide the pressure-bar in its movements to and from the paper.

Pins or cams e'', secured to the hinge-arms g''', project within the loops above the pintles, and, when the cover is swung open by its handle l''', bear against the inner sides of the loops, to move them back and retract the pressure-bar from the fillet of paper. This construction facilitates the application and removal of the paper record, because the act of opening the cover draws back the pressure side and widens the space between it and the gage side S$''$. When the position of the pressure-bar is changed by adjusting the spring C$''$, the guide-loops are also changed with it, and may, therefore, be so placed that the cams will have no effect to move them when the cover is opened. To overcome this difficulty the pintle-blocks are made adjustable by means of slots and set-screws, as shown in Fig. 3, so that they may also be changed whenever the position of the pressure-bar is altered by the springs. The adjustment of the pintle-blocks is also necessary to compensate for wear of the loops and cams, and may, in such case, be made without adjusting the springs. The outer edge of the cover is formed with a series of lateral projections, which fit between the projections on the pressure side when the cover is closed, for the purpose of preventing the edge of the paper from curling up or wrinkling as it is drawn over the bed. The pressure or weight of the cover upon the fillet of paper is regulated by a set-screw, n'''', which passes down through a lateral plate or projection on the swinging edge of the cover, and bears upon the arched top of the guide side S'', as shown in Fig. 3. The opening between the cover and guide-bed is the deepest at the rear end where the paper enters, to afford room for the passage of the paper when two fillets are pasted together at the ends. The shaft j' of the gage-fingers is operated from the driving-pulley D in the following manner: n' is an inclined shaft, having its bearings, respectively, in the side of the upright A, and in a hanger, o^2, on the under side of the guide-bed. q^2 and r' are beveled pinions, mounted upon opposite ends of the shaft, the former to engage with a beveled pinion, m'', on the end of the shaft j', and the latter with a beveled gear-wheel, S', mounted upon a short stud in the side of the upright beneath the driving-pulley. Motion is communicated to the gear-wheel from the driving-pulley by means of two friction-wheels, t', mounted upon a vertical shaft, V', so as to bear against the faces of the gear-wheel and pulley between their respective shafts. The friction-wheels are clamped to their shaft between a fixed plate, k''', and a screw-plate, n'', by which means they can be readily applied and removed when desired. The faces of the wheel and pulley are corrugated, notched, or otherwise roughened in radial lines, to prevent the friction-wheels from slipping; and to still further guard against such difficulty, and at the same time prevent too much wear, the friction-wheels are made of leather, vulcanized rubber, or other yielding substance. The shaft of the friction-wheels works within a long tubular bearing, W', which, to prevent it from turning, is squared upon the outside, and fitted within corresponding recesses in the parallel arms y', secured to the side of the upright. Flat springs a''', attached to the parallel arms, bear against the tubular bearings, to hold the friction-wheels against the pulley and gear-wheel, the degree of pressure being controlled by set-screws j''.

The instrument is operated by a belt or band, having a frictional connection with a suitable motor, and passing around the grooved driving-pulley, so as to move it in the direction of the arrow, Fig. 1. Its motion is communicated, through the connections above described, to the shaft j', and moves it and the gage-fingers in the opposite direction. The gage-fingers are held upon the shaft j' independently of each other, being mounted upon friction-sleeves S''', having a loose segmental gear, e^2, between them. Each sleeve is composed of two half-boxes, held upon the shaft by a spring, t''', bent to embrace them, and which is secured together at the ends by a screw, n'''''. By adjusting this screw, the ends of the spring are moved to and from each other, for the purpose of regulating the force with which the sleeves shall grasp the shaft.

When the fillet of paper containing the message-slits to be produced in printed characters is placed in the guide-bed, the cover of the latter is shut down upon it and the pressure-roller released, so as to hold it in contact with the feed-cylinder. The paper is arranged with the concave side of the parallel grooves fitting upon the ribs of the bed, and the gage side S'' adjusted up to its edge, for guiding it properly to the roller, and so that its slits shall register with the points of the gage-fingers. The pressure-bar is adjusted to bear against the opposite edge with sufficient force to guide it without wrinkling. The gage side and pressure-bar thus guide the paper to the pressure-roller, with its embossed tracks within the parallel grooves thereof and on the ribs of the bed, for the purpose of insuring the proper registry of the slits with the gage-fingers. If the points of the fingers do not accurately coincide with the slits, they are further adjusted by set-screws c^2, bearing against their sides, and held in the ends of arms a^2, rising from the friction-sleeves. This guidance of the paper directs its tracks within the parallel grooves of the pressure-roller, for the purpose of preserving the form of the tracks, in order that the paper may be used as often as desired to reproduce the message. After the paper has been adjusted, the instrument is set in motion to move it over the bed. Its pressure is sufficient to overcome the force of the friction-sleeves S''', and hold the points of the gage-fingers below the surface of the bed, within the slots at the front end of the arch. When, however, a slit in the paper presents itself to the point of a gage-finger, the pressure of the paper is removed, so that the friction-sleeve turns with the shaft j', and throws the gage-finger back to the rear end of such slit, where it is again arrested by the paper and moved forward to its starting-point. Thus the fingers are alternately thrown back and carried forward as the alternate rows of message-slits present themselves, the length of their backward throws being governed by the length of the slits, for the purpose of setting the type-wheel, as I will presently describe. It is essential that the force with which the friction-sleeves grasp their shaft shall not be strong enough to cause the fingers to tear the paper when thrown back to the rear ends of the slits, and since the paper fillets may sometimes vary in strength, or the speed of the machine increase the force of the fingers, the friction-sleeves are made adjustable, as above described, so that the fingers may be thrown back with a force proportioned to the resisting-strength of the paper at the ends of the slits.

A curved guide, i'', secured to the front upright A of the frame, under the feed-cylinder, serves to direct the slitted record out of the instrument.

After a slitted record has passed out of the guide-bed it often occurs that the gage-fingers have not been returned to the front of the arch, and, inasmuch as their return to such point is necessary before a new record can be applied to the guide-bed, I have provided the following means for effecting this result by operating the arm of the pressure-roller F. A bent lever, i^2, is hung upon the end of a horizontal arm, j^2, projecting inward from the upright A^3 to a point near the gage-fingers. Its horizontal portion extends in front of such fingers, and the upper end of the upright portion is connected, by a long rod, h^2, to the shaft or pin of the pressure-roller. When the arm of the pressure-roller is moved away from the feed-cylinder the connecting-rod moves the bent lever against the lower ends of the gage-fingers, to throw their points to the front of the arch, as will be clearly understood by reference to Fig. 1.

The mechanism thus far described is employed solely for feeding and otherwise manipulating the record containing the message-slits, so that it shall be operated upon by the mechanism for reproducing the message in printed characters, as I will now proceed to describe.

A^2 and A^3 are uprights arranged upon the frame of the instrument, the former a short distance in rear of the upright A, and the latter across the frame opposite the upright A^2. P is a light type-wheel mounted upon a shaft, Q, having its bearings in these two uprights, near the top, and carrying a small pinion, m^1, which engages with the segmental gear e^2 on the shaft of the gage-fingers. The segmental gear carries a cross-bar, f^2, at or near its rim, of sufficient length to bear against the rear edges of both gage-fingers. When the fingers are at rest in front of the arch of the guide-bed the type-wheel is also at rest, with a blank space or type at the top; but when a finger is released by the presentation thereto of a slit in the moving fillet of paper, it presses against the cross-bar and bears back the segmental gear, so as to turn the pinion m^1, and with it the shaft and type-wheel, in the direction of the arrow, Fig. 1. The type-wheel continues to move until the finger is arrested at the rear end of the slit, when it stops with the required type at the top, in a position to print upon the blank paper when the pressing mechanism is brought down upon it. After the impression has been taken, the paper at the end of the slit again moves forward the gage-finger to the front of the arch, and the type-wheel is turned back to its first position by the influence of the suspended weight f^4 upon the type-wheel shaft. This return movement also causes the pinion m^1 to carry back the segmental gear and hold the cross-bar f^2 in contact with the returning gage-finger, so that it shall be in position to receive the action of the adjoining finger for again setting the type-wheel. The weight, therefore, serves the twofold purpose of holding the cross-bar up to the gage-fingers for setting the type-wheel, and returning the latter after it has been set. A spring, however, may be employed for this purpose instead of the weight, if preferred. From this description it will be seen that the type-wheel starts always from the same point to bring the required type under the pressing devices, and is returned to such point after the impression has been taken.

The type are arranged at regular intervals upon the wheel, and the distance the latter must turn to bring the required letter under the pressing devices is governed by the length of the message-slits in the moving fillet of paper, or, in other words, the gage-fingers are thrown back to different points, according to the length of the slits, and therefore move the wheel a greater or less distance to bring the required type uppermost under the pressing mechanism.

In placing the type upon the type-wheel I have transposed the alphabet and followed the number of signs and the order of arrangement adopted in the recording-instrument, for the purpose of harmonizing therewith, and so that the type-wheel shall move the shortest distance for the message-symbol most frequently used, its throws gradually increasing in length as the letters or symbols decrease in use. By this means the type-wheel may also be operated with great rapidity to print a message accurately from the copy or slitted record-fillet. A^4 is a bracket, arranged upon the rear side of the upright A^3, near the top, and provided with a horizontal stud, S^2, projecting inward toward the upright A^2. n^2 is the pressing or platen cylinder, borne immediately over the type-wheel, and at right angles thereto, by means of a pin, z^2, in the forward end of an arm, a^3, which, in its turn, is hung upon the stud of the bracket.

The bracket is slotted and adapted for adjustment by a set-screw to regulate the position of the platen-cylinder with respect to the type-wheel. The cylinder is constructed with a series of flattened surfaces or platens, and with a row of circumferential teeth or spurs at each end of the platens. r^2 is a wide flat arm articulated upon the stud S^2 and formed with a concave front end to fit up against the under side of the platen-cylinder, for the purpose of supporting and holding the fillet of paper q, upon which the message is to be printed, in contact with the platen while an impression is being taken. The concave end is slotted for the passage of the type upon the wheel beneath, and is also grooved to receive the spurs, by which the paper and ink-band are fed along. A spring, t^2, attached to the stud, and to a projection on the side of the arm r^2, holds the latter up to the cylinder and insures the action of the spurs upon the paper. k^2 is the endless ink-band passing around the platen-cylinder and its spurs, and around a roller, l^2, mounted upon the frame of the instrument in rear of the guide-bed. The ink-band is fed along upon the arm a^3, over the plain fillet of paper q, which, after receiving the impression of the type-wheel, passes out of the instrument along a horizontal table, q^5, secured to the front of the upright A^3, in line, or nearly so, with the arm a^3, as shown. x^2 and y^2 are reversed ratchet-wheels, or rows of ratchet-teeth, formed beside each other upon the end of the platen-cylinder, next the arm a^3, and there are as many teeth in each row as there are platens upon the cylinder. The row x^2 is employed in connection with a spring-pawl, f^3 d^3, pivoted immediately above it to the upright A^3, for the purpose of rotating the platen-cylinder to feed the ink-band and fillet of paper over the type-wheel, while the teeth of the row y^2 engage with the fixed pawl e^3 on the upright to prevent the platen-wheel from being rotated too far by its momentum. A flat spring, c^3, hung to the under side of the arm a^3, engages the ratchet-wheel y^2 with its forward end, and prevents the platen-cylinder from rotating backward. This spring is held at the proper distance from the arm to operate as a locking-pawl, by means of a short stud, c^4, on the under side of such arm, as shown in Fig. 1. l^3 is a cam-shaft, having its bearings in the uprights A^2 A^3 at some distance below the shaft of the type-wheel. It is employed to move the printing-platen down upon the type-wheel, and to apply a brake to the driving-pulley for the purpose of stopping the movement of the slitted fillet while an impression is being taken upon the printed fillet.

j^3 is a cam secured to the end of the shaft l^3 under the pressing mechanism, and h^3 is an upright rod mounted upon the cam by an eccentric band, h^4, with its upper end entering a socket, g^3, hung upon the inner end of the pin z^2, which carries the platen-cylinder. The socket and rod are connected by a spring, k^3, coiled round the latter, so that when the cam-shaft is rotated the platen-cylinder will be vibrated vertically over the type-wheel, the arms r^2 a^3 turning freely on the stud S^2 for this purpose. When the longest radius of the cam is underneath the shaft the rod and socket are separated somewhat, and the tension of the spring pulls down the platen-cylinder to press the ink-band and paper against the letters of the type-wheel. The printing is, therefore, done by the force of the spring at each revolution of the cam-shaft. As the cylinder is moved up by the rotation of the shaft, and just before it reaches the limit of its upward throw, a tooth of the ratchet x^2 encounters the spring-pawl d^3, and rotates the cylinder the distance of one tooth and platen, as above stated, thereby causing the spurs to feed along the ink-band and paper to receive the next impression of type. m^3 is another cam fixed upon the opposite end of the shaft l^3 to support the lower forked end of an inclined brake or stop bar, n^3. The forward or upper end of this bar fits and works within an inclined groove in the side of the front upright A, under the feed-cylinder B, and carries at its extremity an adjustable stop, i^3, which nearly touches the projecting shaft of the pressure-roller F when the latter is in contact with the feed-cylinder. An adjustable brake, b^3, is also attached to the bar, and is curved round to the opposite side of the upright, so that its shoe shall occupy a position just under, and slightly to the rear of, the driving-pulley B. The forward end of the brake is guided and supported by a notch in the rear end of the upper arm y', or in any other proper and convenient way. The two cams j^3 and m^3 are so arranged upon their shaft that, when, under the influence of the former, the printing devices are making an impression upon the paper, the latter will throw the brake against the driving-pulley and prevent its further rotation. This stops the movement of the slitted paper fillet, and, therefore, the movement of the gage-fingers and type-wheel until the impression has been completed. The periphery of the driving-pulley may be roughened, if desired, to render the action of the brake more certain. When the brake is applied, the stop i^3 moves out the pressure-roller F from contact with the paper, and prevents the possibility of any failure in arresting the movement of the latter at the proper instant. One of these stopping devices might, perhaps, be dispensed with without impairing the efficiency of the instrument; but I prefer to employ them both to prevent accidents, in case one should fail to perform its office. The brake and stop are made adjustable to compensate for wear and to enable them to be brought into action at the proper time. t^3 is a time-shaft, having its bearings in the uprights A^2 and A^3, between the cam-shaft and the shaft of type-wheel, and b^4 is an upright arm, secured to the time-shaft, beneath the type-wheel. The upper end of the arm carries a pivoted pawl, a^4, to engage with a row of adjusting-teeth, o', on the side of the type-wheel, equaling in number the type on the periphery. The point of the pawl is held up to the teeth by a spring, d^4, secured to the time-shaft in any convenient manner, and the extent of its upward movement is limited by a stop, c^4, at the top of the pawl-arm.

The time-shaft is further constructed, beside the pawl-arm, with a transverse open frame of quadrangular shape, which tips forward and back when the shaft is oscillated. The front surfaces of the forward and rear sides of the frame form stops or detents v^3 and w^3, respectively, for the long radial detent-arm o^3, secured to the cam-shaft beneath. The point of the detent-arm rests against the forward stop when the time-shaft is stationary. The cam-shaft and time-shaft are driven by the same motor that moves the driving-pulley, and its power is communicated to them by means of belts or bands running over pulleys q^3 r^3 attached to friction-sleeves thereon. The pulleys and sleeves rotate continuously in opposite directions, as shown by the arrows, Fig. 1, and grasp their shafts with sufficient frictional force to rotate them also, excepting when they are locked by the stopping or detaining devices. When this occurs the friction-sleeves turn on the shafts, so that their rotation is unimpeded. The friction-sleeves are each composed of two half-boxes held together upon the shaft by bolts and nuts, and by springs S^3 surrounding the bolts. By moving the nuts the tension of the springs is adjusted to regulate the force with which the sleeves shall grasp the shafts. The pulley r^3 is made in two parts, one being a flat disk secured firmly to the friction-sleeve, and the other a shallow drum or barrel mounted loosely upon the sleeve, and containing a coiled spring. One end of the spring is secured to the drum, and the other to the disk, so that, when the cam-shaft is stationary and the drum is moved by the driving-belt, it will wind up the spring until its tension overcomes the frictional force of the sleeve, and causes the latter to turn also. When the detent-arm o^3 of the cam-shaft is released by the stops of the time-shaft the force of the coiled spring throws the shaft, cams, and arms rapidly round, and thus insures their prompt action without expending the power of the motor, which would otherwise be required to drive the belt, and, therefore, the shaft and its attachments, at the proper speed.

The operation of the instrument to produce a printed message is as follows: The slitted record is first set in motion over the guide-bed, as above described, and the plain fillet laid upon the spring-arm r^2 over the type-wheel and under the ink-band and pressing-cylinder. As the moving record-fillet presents a slit to one or the other of the gage-fingers, the latter is thrown back to the rear end of the slit, as already stated, thereby turning the type-wheel to bring the type which corresponds to the slit up under the plain fillet, beneath the pressing-cylinder. When the type-wheel moves it bears back the spring-pawl a^4 and pawl-arm b^4 to oscillate the time-shaft, and release the detent-arm o^3 from the front stop v^3, so that the cam-shaft shall be turned by its driving-force and throw the point of the detent-arm o^3 against the rear stop w^3. At the instant the type-wheel stops, the point of the spring-pawl just clears the side teeth, thus allowing the time-shaft to be tipped forward by its driving-force, and again throw forward the pawl to engage the teeth farther under the wheel. The forward tip of the time-shaft clears the rear stop w^3 from the detent-arm, and permits the cam-shaft to revolve, so that its cams m^3 j^3 shall simultaneously, as near as may be, apply the brake to the driving-pulley B for stopping the feed of the slitted paper, and bring down the pressing-cylinder to bear the plain fillet upon the type for taking the impression. The cam-shaft rotates until the detent-arm is again arrested by contact with the front stop v^3, which is thrown down when the time-shaft is tipped to clear the detent-arm and stop w^3.

The oscillations of the time-shaft are limited by an inclined plate, x^3, attached by a set-screw, x^4, to the side of the upright A^3, immediately over the stops v^3 w^3. By varying the inclination of the plate, the oscillations of the time-shaft are also varied to adjust the throw of the spring-pawl with respect to the type-wheel.

As soon as the impression is taken the rotation of the cam-shaft carries round the cams m^3 j^3, the first to release the brake and unlock the driving-pulley B, so that the slitted fillet of paper may continue its forward movement over the guide-bed, and the second to throw up the pressing devices, feed the printing fillet of paper forward, and release the type-wheel, in order that it may be returned to its first position by the weight, as hereinbefore described. In the return movement of the type-wheel its side teeth strike the point of the locking-pawl a^4, which, owing to its supporting-spring, yields readily for their passage. Thus, at each oscillation of the time-shaft, and each corresponding revolution of the cam-shaft, the type-wheel is set, the slitted fillet stopped, and the impression taken upon the plain fillet simultaneously or in rapid succession, the pressing-cylinder lifted from the type-wheel, the slitted fillet of paper again set in motion, the printing-fillet fed forward, and the type-wheel returned to its first position. In other words, the type-wheel is set, the impression taken upon the plain fillet of paper, and the various parts returned to their first positions ready to repeat the operation when another slit in the record-fillet releases a gage-finger.

When the printing devices are pressed down to do the printing, a short correcting-tooth, v^4, on the under side of the spring-arm r^2, enters between the two top teeth on the side of the type-wheel, for the purpose of locking it in position and causing it to register accurately with the platens of the pressing-cylinder. This provision insures a correct impression of the type.

The speed at which the slitted record is fed over the guide-bed is practically the same under all circumstances; but the speed of the shaft j' must be adjusted relative to the feed of the slitted record for the purpose of securing the proper throw of the gage-fingers to set the type-wheel. The speed of this shaft is first gaged to the standard length of slits made in the first produced record—*i. e.*, the record made by the recording-instrument hereinbefore referred to. If, however, from any cause the standard length of the slits is varied, the speed of the shaft must be correspondingly varied. For example, if the slits become shortened, the gage-fingers, when thrown back by the shaft, encounter the rear end of the slits before the type-wheel has had time to bring up the corresponding types into position for printing. This variation in the standard-slits necessitates a slight increase in the speed of the shaft, in order that the gage-fingers may be thrown back a little quicker to meet the rear ends of the slits. When the slits become lengthened beyond the standard the gage-fingers throw the type-wheel too far, and the speed of the shaft j' must, therefore, be decreased.

To regulate the speed of the shaft j' the friction-wheels t' are adjusted vertically upon the faces of the grooved pulley D and gear-wheel S′, so as to take the motion of the former at any suitable point between its center and cirfumference, and transmit it to the latter in the same manner.

This adjustment is effected by the following mechanism: z'' is a cross rock-shaft, having its bearings in blocks f''' i''' at the rear of the instrument, behind the guide-bed sleeve, and carrying at its outer end a long horizontal arm, r'', extending forward under the gear-wheel S′. This arm is connected by a vertical rod, b''', to a second and shorter horizontal arm, p'', pivoted at its rear end to the upright A^2, and jointed at its front end to the center of the tubular bearing W′. k''' is a stop-bar rising from the inner end of the rock-shaft, just behind an upright, q''', attached to the bearing f''', and o''' is a flat spring, fastened at its lower end to the front side of the stop-bar, about midway thereof. m''' is a long flat metal strip, secured to the top of the spring, or forming a continuation of the same, and terminating at its upper end in a beveled gage-point, which projects through a longitudinal slot in the gage side of the guide-bed, at the rear end, as shown in Fig. 1. The spring gage-point is arranged to move edgewise through the slot in line with a beveled gage-point, i', attached to the side of the guide-bed, and adapted for adjustment by means of a slot and set-screw, as shown.

The beveled edges of the gage-points are placed opposite each other, so that their outer edges shall form catches to bear against the opposite ends of a slit in the record-fillet, when such slit is hooked over them. Instead of arranging the two gage-points in or upon the guide-bed, they may be placed upon the frame of the instrument, beside the guide-bed, or at any other convenient point.

The gage-point m''' is adjusted with respect to the gage-point i' by means of a set-screw, p''', passing through the stop-bar to bear with its point against the upright q'''. A spring, j''', coiled about the rock-shaft, and secured at one end to the bed of the instrument, holds the set-screw against the upright q''', and prevents the parallel arms r'' p'' from being casually moved up to displace the friction-wheels. When the speed of the shaft j' is to be adjusted by this mechanism one end of the longest slit in the record-fillet is hooked over the gage-point i'. The point m''' is then placed within the slit and adjusted up to its opposite end by the set-screw p''', the spring of the gage-point preventing the paper from being torn by the back of the point in case the stop-bar is moved too far from the upright q'''. To afford nicety of adjustment, and to relieve the tension of the spring, a set-screw, r''', is employed, passing through the top of the stop-bar, and bearing against the back of the spring, as shown in Fig. 1. The operation of the set screw p''' moves the stop-bar with respect to the upright q''' and, through the connecting devices, raises or lowers the friction-wheels upon the driving-pulley B and gear-wheel S′, to change the speed of the latter, and therefore the speed of the shaft j' and its gage-fingers, proportionally. Thus the variation in the standard length of the slits furnishes the guide for adjusting the speed of the shaft j' relative to the speed of the driving-pulley, for the purpose of securing the proper throw of the gage-fingers within such slits, to set the type-wheel.

Instead of employing the set-screw p''' and coiled spring to adjust the gage-point m''', right and left set-screws may be arranged in the stop-bar and upright for this purpose; and, in place of the several arms for communicating the motion of the rock-shaft to the friction-wheels, a single arm may be arranged upon the rock-shaft to connect with the tubular bearing of such wheels in any convenient way.

It may happen that, from inadvertence in the original construction of the instrument, and from wear of the parts, more particularly the friction-wheels, the adjustment of the gage-points produces a movement of the friction-wheels slightly more or less than is required. In such case the connecting-rod b''' is adjusted by any suitable means upon the parallel arms p'' r'', so as to increase or diminish the movement of the friction-wheels when operated by the gage-points, and thereby cause the movement of the latter to produce precisely the required adjustment of the driving-wheel.

A^5 represents a pair of shears, attached to the top of the upright A^3, over the type-wheel, between the printing devices and the guide-table q^5, for the purpose of severing the printed record from the plain fillet of paper. The blades of the shears are held apart so that the fillet may travel between them, by a spring, q^6, connecting the lower blade with a set-screw, q^7, as shown by dotted lines in Fig. 2, near the foot of the upright. The spring also serves to throw open the blade again, after it has been closed by the operator, to cut off the record.

A second spring, q^8, connects the handle of the lower blade with a set-screw, q^9, in the side of the guide-table, for the purpose of holding such blade up to the stationary blade, and insure the proper action of their cutting-edges. By adjusting the set-screws the tension of the two springs is preserved to render the blades certain in their action at all times.

The paper fillets for both the original and reproduced records are prepared for use by treating them with an extra sizing of glue, in order to prevent them from being torn by the knives during the slitting operations.

The drawings herein illustrate one form of my invention; but I desire it understood that I do not confine myself to such form so long as I do not depart from the principle of my invention.

Having thus described my invention, what I claim is—

1. The system of harmonized mechanism, constituting a complete electric telegraph, and composed of an instrument by which the written messages received at a station are recorded in a fillet of paper to be used as the medium for automatically transmitting the messages from one station to another, the batteries and insulated wires constituting the line or lines; a sending-instrument adapted, in connection with the record-fillet, to automatically transmit to the receiving-station message-signals corresponding to the record-signs of the fillet; a receiving-instrument adapted to receive such electric signals, and thereby automatically produce at the receiving-station an exact fac-simile of the original record-fillet at the sending-station; and mechanism adapted to receive such reproduced record-fillet, and therefrom automatically produce a dispatch for delivery printed in ordinary typographic characters.

2. The combination of two or more telegraph-lines, having harmonized automatic sending, receiving, and reproducing instruments, substantially as described, whereby either an original record-fillet or a reproduced record-fillet of one line can be used equally well to automatically operate any other line.

3. The mode or process of transmitting intelligence to a distance over a succession of telegraph-lines, substantially as herein described—that is to say, by, first, producing at the sending-station a record of the dispatch to be transmitted; second, automatically transmitting electric impulses along the line to the receiving-station by means of the message fillet or record produced as aforesaid; third, automatically reproducing at the receiving-station of a line, by means of said electric impulses, a fac-simile of the record at the receiving-station; fourth, using at the proper receiving-stations the successively reproduced records, to automatically transmit the message over each succeeding line, until the final or delivery station is reached; and, fifth, using the reproduced record at such station to automatically print the message in ordinary typographic characters for delivery.

ROYAL E. HOUSE.

Witnesses:
L. HILL,
E. A. ELLSWORTH.