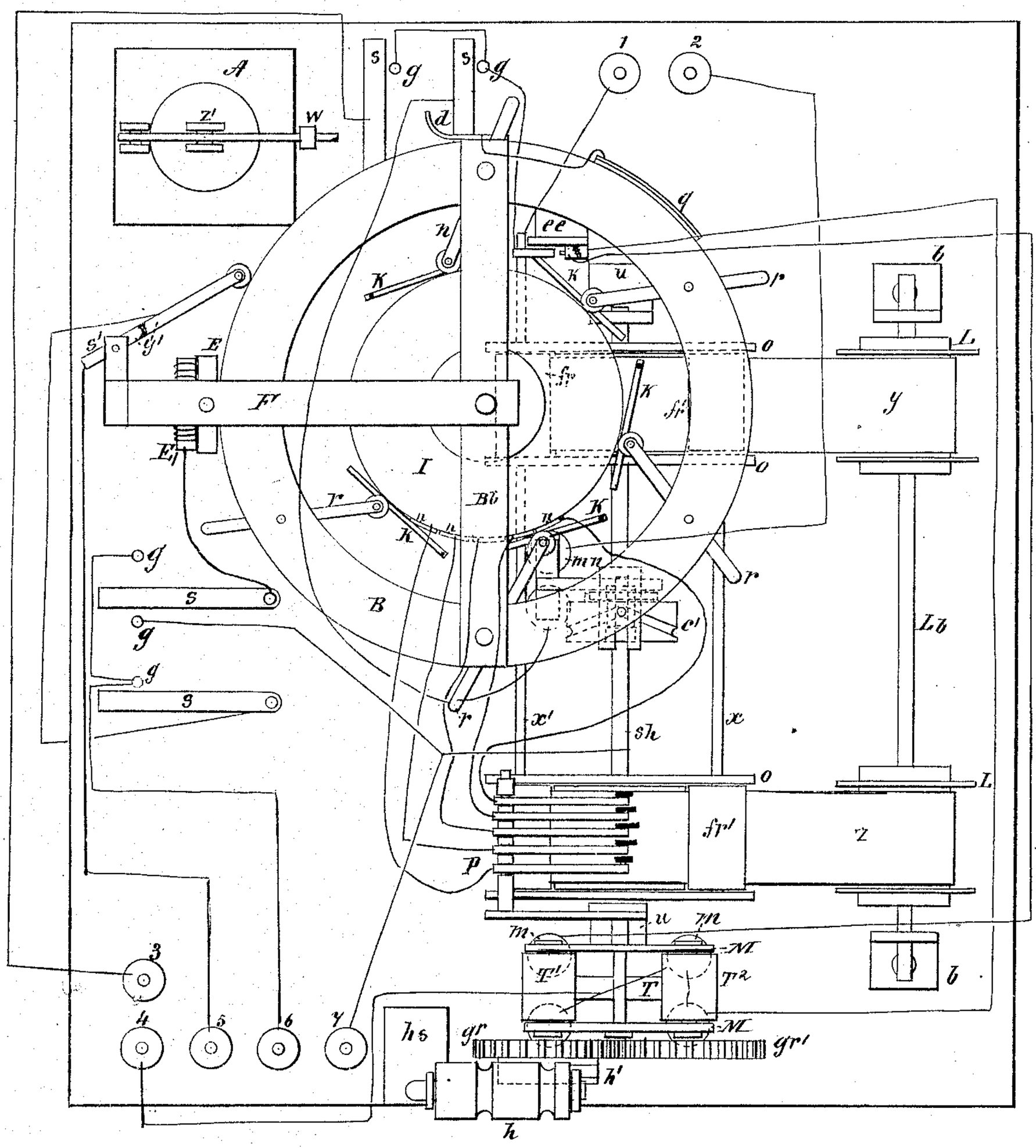
3 Sheets--Sheet 1.

W. E. SAWYER.

Automatic and Autographic Telegraph and Circuit.

No. 159,460. Patented Feb. 2, 1875.

Fig. 1.



WITNESSES:

Solon C. Kemon

Chas. A. Pettit

INVENTOR:

Wm. E. Sawyer

BY Munn & Co

ATTORNEYS.

3 Sheets--Sheet 2.

W. E. SAWYER.

Automatic and Autographic Telegraph and Circuit.

No. 159,460. Patented Feb. 2, 1875.

Fig. 2.

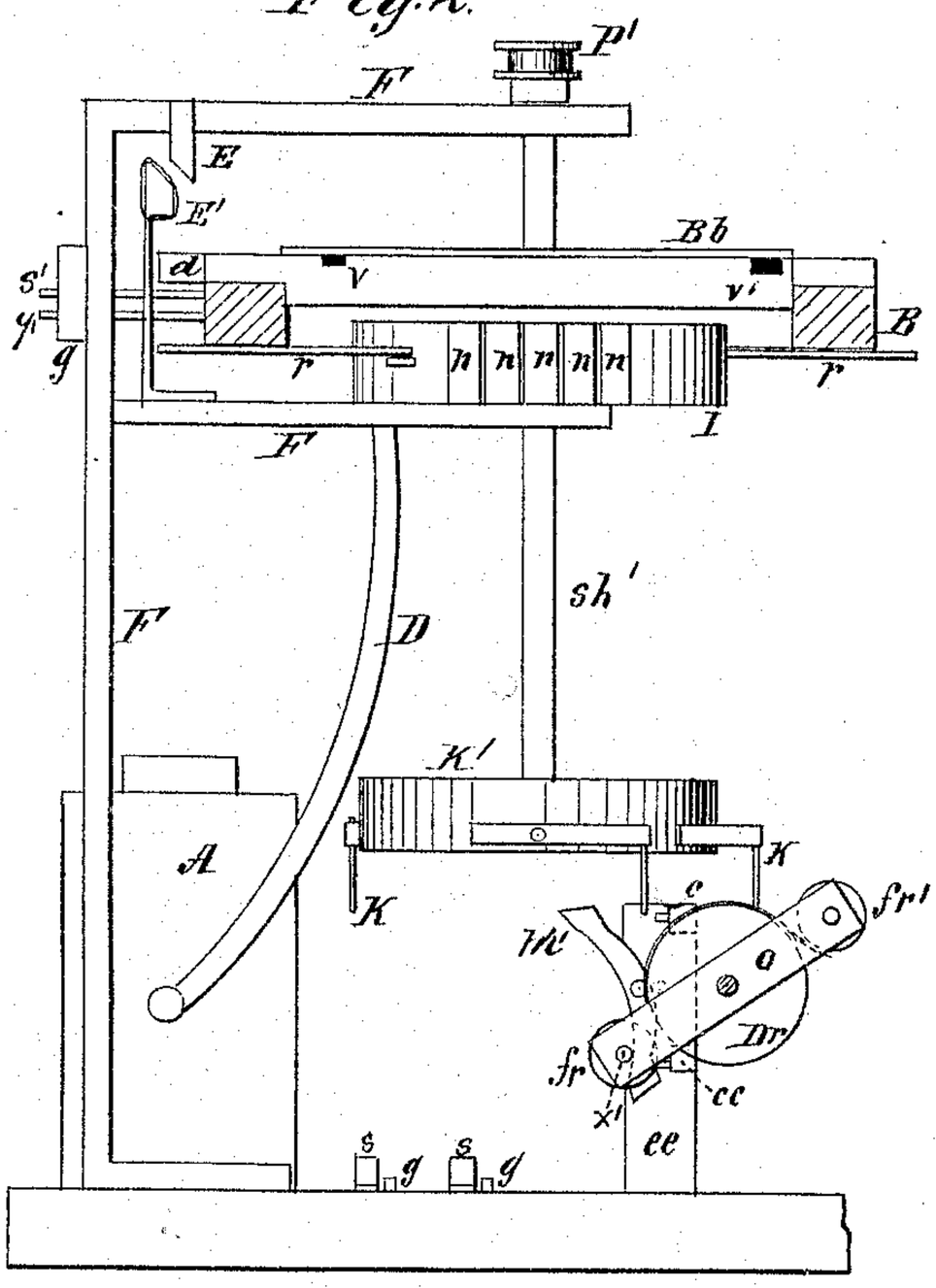


Fig. 3

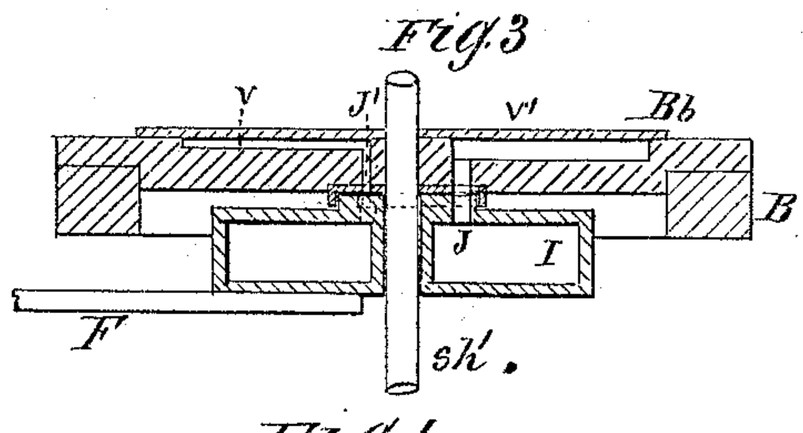


Fig. 4.

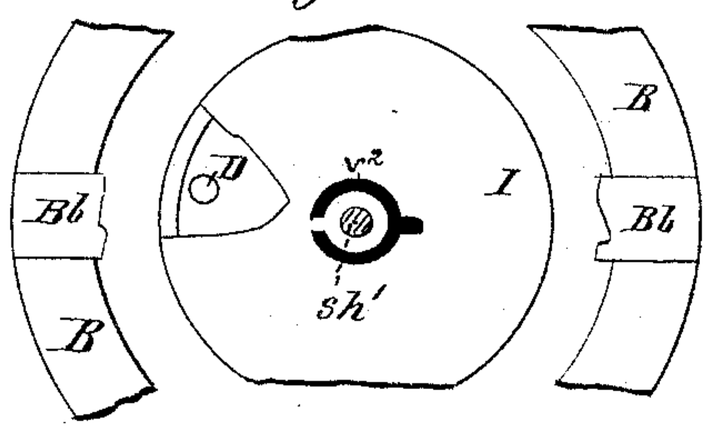


Fig. 5.

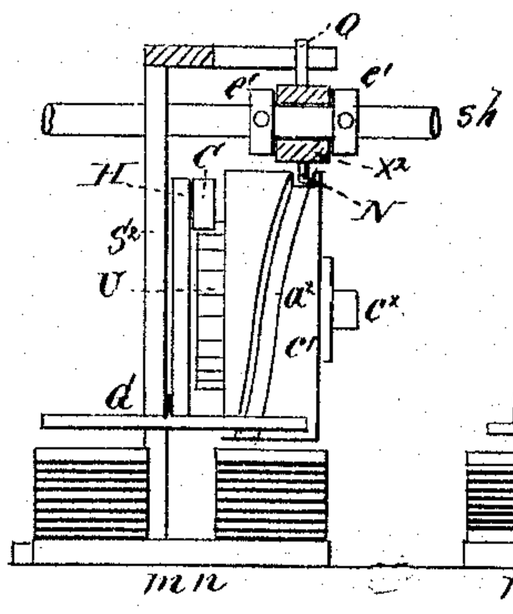


Fig. 6.

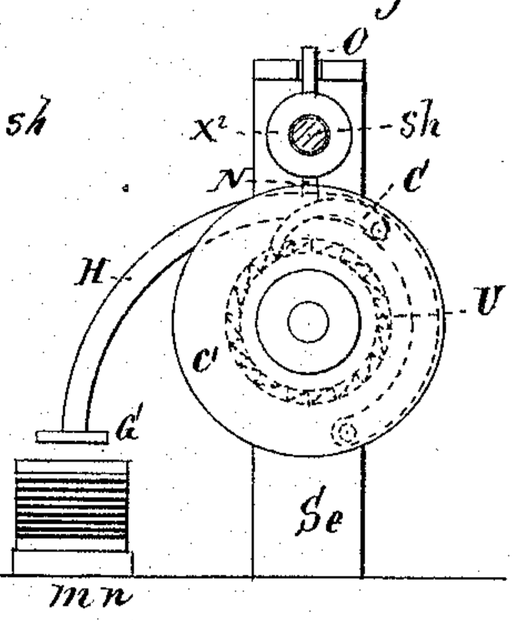


Fig. 7.

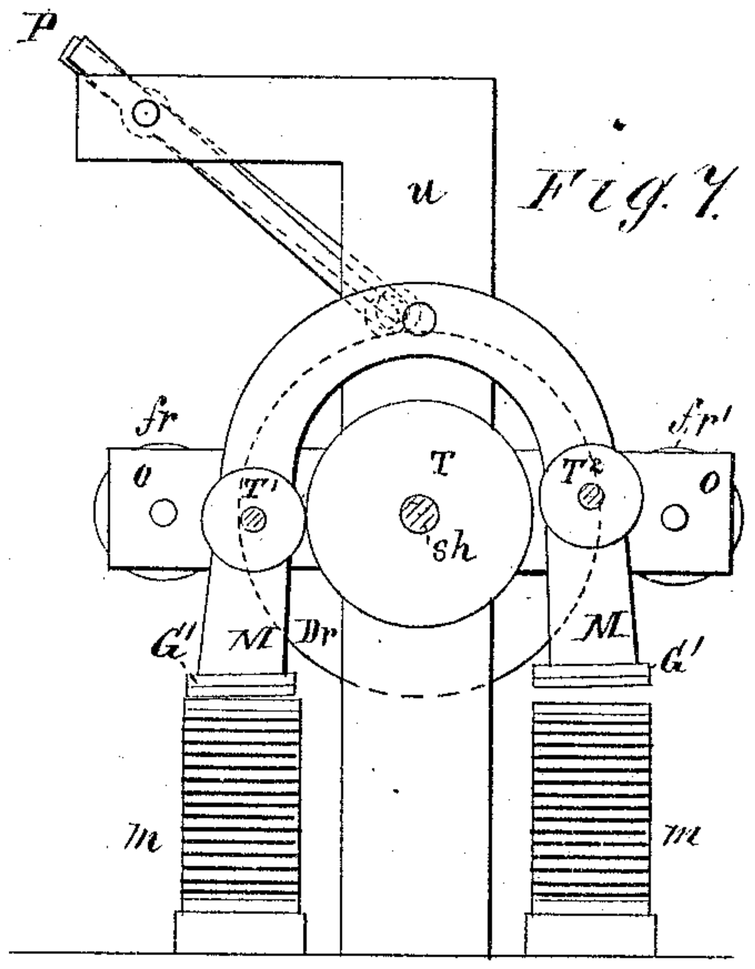
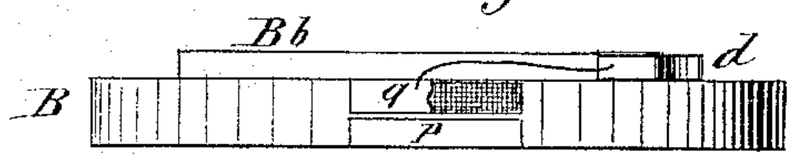


Fig. 3.



WITNESSES:

Solon C. Kemon

Chas. A. Pettit

INVENTOR:

Wm. E. Sawyer

BY Munn & Co

ATTORNEYS.

3 Sheets--Sheet 3.

W. E. SAWYER.

Automatic and Autographic Telegraph and Circuit.

No. 159,460. Patented Feb. 2, 1875.

Fig. 9.

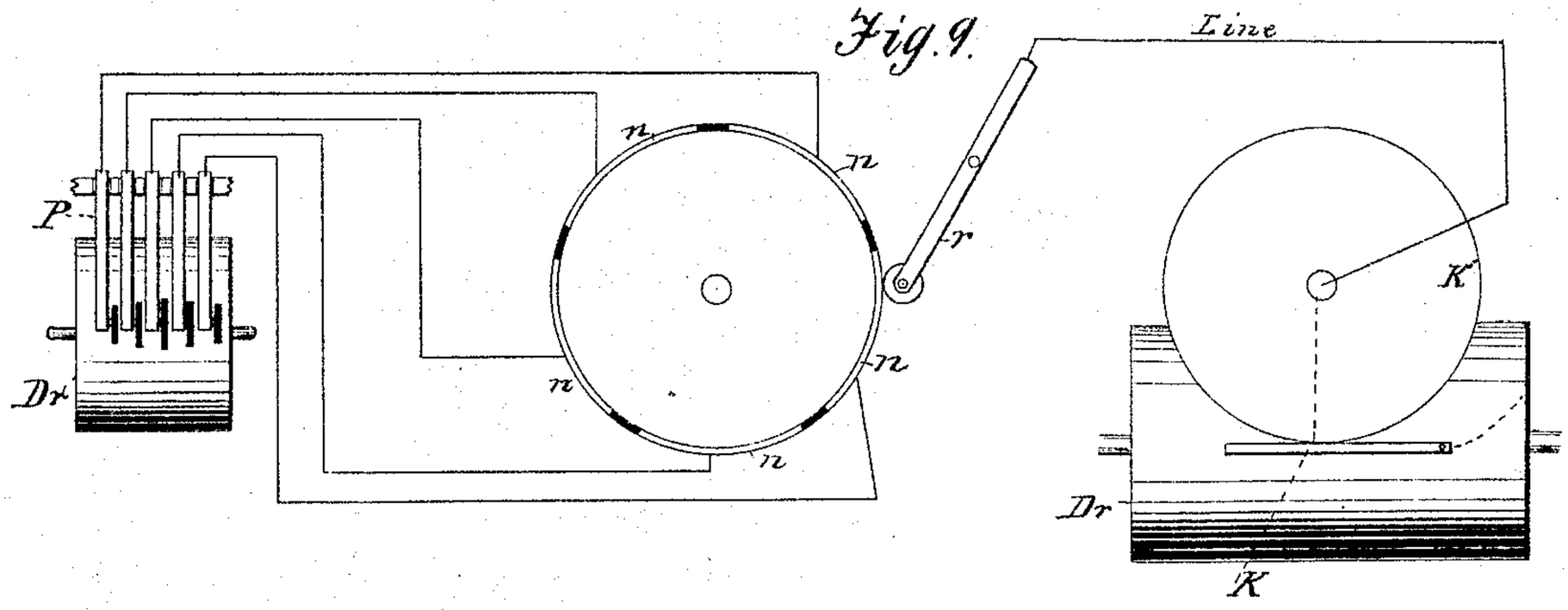


Fig. 10.

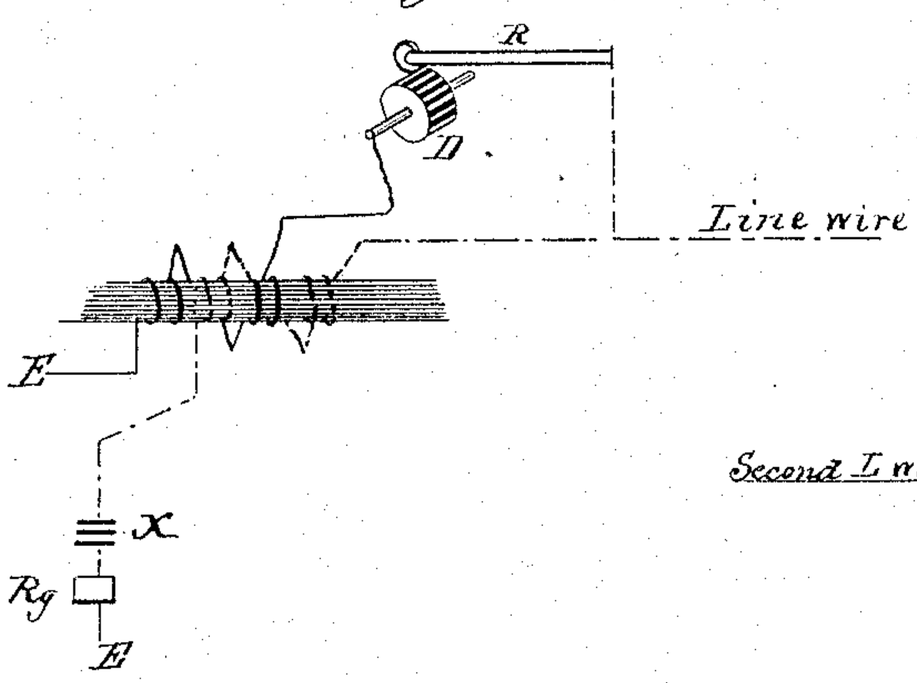


Fig. 11.

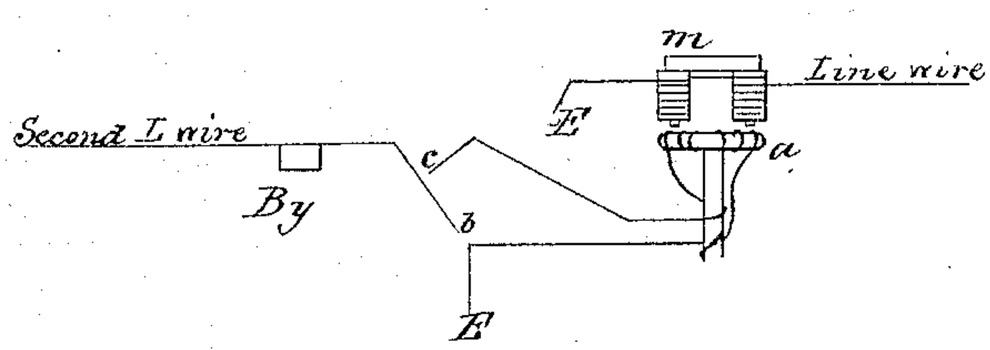
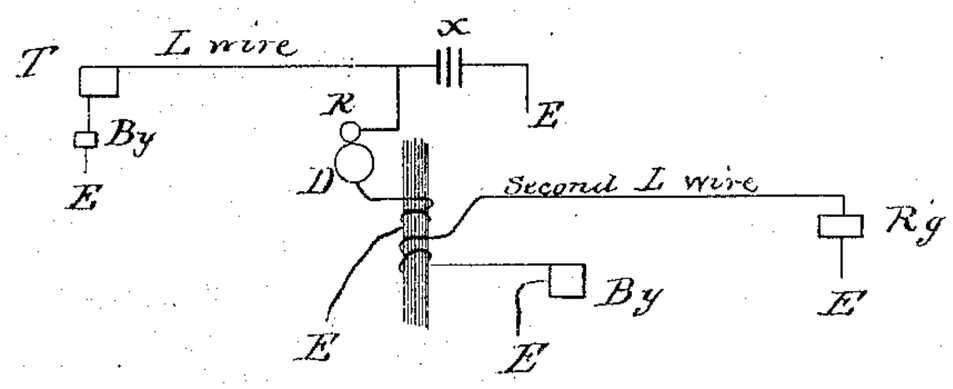


Fig. 12.



WITNESSES:

Solon C. Kemon
Chas. A. Pettit

INVENTOR:

Wm. E. Sawyer

BY Munn & Co

ATTORNEYS.

UNITED STATES PATENT OFFICE.

WILLIAM E. SAWYER, OF WASHINGTON, DISTRICT OF COLUMBIA.

IMPROVEMENT IN AUTOMATIC AND AUTOGRAPHIC TELEGRAPHS AND CIRCUITS.

Specification forming part of Letters Patent No. **159,460**, dated February 2, 1875; application filed October 19, 1874.

To all whom it may concern:

Be it known that I, WILLIAM EDWARD SAWYER, of Washington, in the District of Columbia, have invented certain new and useful Improvements in Chemical Copying-Telegraphs, Electrical Circuits, and apparatus connected therewith, otherwise designated as fac-simile, autographic, or pantographic telegraphs or pantelegraphs, to be known and designated as the new pantelegraph, of which the following is a specification:

My invention relates to a chemical copying-telegraph which is capable of an indefinite speed of transmission; and consists in automatically-working repeating apparatus; in apparatus for the prevention of "tailings;" in new applications to secure and maintain rapid synchronous movements; in a new method of preparation of messages for transmission; in a new method of transmission and reception of messages, by means of which messages are transmitted from and received upon continuous sheets, strips, or rolls of paper, instead of upon paper of a certain size attached to drums or cylinders, and in a new method of transmission and reception of messages by using an indefinite number of contact-points in the transmitting-instrument, and a less number in the receiving apparatus, or any number in the transmitting apparatus, and but one receiving-point; and I do not confine myself to the application of the principles, apparatus, and devices involved and described to copying or fac-simile telegraphs, but they may be applied to any telegraph, and particularly to what is known as the automatic chemical telegraph, whereby messages are transmitted from perforated or otherwise prepared fillets or strips of paper, or other material, and received in dots and dashes or Roman characters, or other symbols, upon chemically-prepared paper.

In the drawings accompanying this specification the principles of construction of the new pantelegraphic instruments or apparatus are clearly shown, and will be fully described.

It is a well-known fact that since the inventions of Bain and Casselli, although many so-called improvements have been made in fac-simile telegraphs, this manner of transmitting messages has never really advanced. The rate of transmission has remained so slow that the pantelegraph has not come into practical or popular use; and it is evident that, after so many trials, the principles of existing systems are inadequate to afford a high rate of speed over a single wire. It is this defect which the new pantelegraph proposes to meet.

My invention is, therefore, founded upon a principle of commutation of indefinite extent and elasticity at the transmitting end of the wire only, the reception of the message being accomplished practically, as now, by a single point.

I am aware that commutators have already been proposed, patented, and perhaps used; but they are founded upon principles differing radically from those of mine, as in the systems of Batewell, De Susini, and Boudouneau, wherein double commutators are employed—*i. e.*, a commutator at the transmitting end of the line, and one corresponding to it at the receiving end. The use of several line-wires has also been proposed, and it is found, in brief, that the heretofore employment of a number of styles necessitates either as many line-wires as there are pairs of styles, or a double commutation.

In the employment of a number of wires in one instrument there is no gain in the speed of transmission over as many wires in as many instruments; and in the employment of a double commutator the difficulties of making the proper connection of one style to its corresponding style perfect and synchronous, and the bad effects of a double connection, one at the transmitting and one at the receiving end of the wire, are so great as to prevent the successful operation of the commutating principle. I therefore employ at the transmitting-instrument a large or any number of styles, five only being shown in the drawing, under which the message to be transmitted is placed; and these styles may be placed to draw imaginary lines of the requisite fineness over the message, so as to cover the message by one passage over it; or, preferably, as shown in the drawings, they may be slightly separated, and the message gradually moved longitudinally; or the

styles may be moved longitudinally, as shown and described herein, so that, by means of the styles passing over the paper, or the styles being stationary and the message in motion, with the longitudinal movement being properly graduated, lines of the requisite fineness may be drawn up and down the message, and in a certain number of motions the message may be covered with these imaginary lines.

I have deemed it preferable to employ fine platina rollers in place of the ordinary styles or points, for making connections with the message, as the disconnection is more perfect on account of the impossibility of scratching away the insulating portions of the message, which frequently occurs when the ordinary style is employed. Each of these styles is connected with a small metallic plate, stud, or piece, preferably of platina, placed either in a circle or arc of a circle, upon what is practically a plane surface, or upon the periphery of a drum, band, or wheel, as shown and described herein, preferably in the latter form. A metallic roller having a bearing upon these plates, studs, or pieces, and in connection with the single line-wire, makes contacts with them, and transmits in succession the currents or electrical impulses, which the message permits to proceed from the battery through the styles. This connecting-roller is carried by a band or similar means over the plates, studs, or pieces; or the roller may be stationary, and the plates, studs, or pieces may be in motion. The receiving apparatus consists of a drum, upon which is placed chemically-prepared paper, and over and bearing upon the paper is carried a marking style or point longitudinally in the arc of a circle, thus drawing lines lengthwise, although in the arc of a circle, instead of around the drum, as in present copying-telegraphs; but the application of a point or points carried round a cylinder, or carried in a circle relatively the opposite of that shown in the accompanying drawings, may be made. This receiving-style moves synchronously with the transmitting-roller, making connections, through the plates, studs, or pieces, with the transmitting-styles.

To increase the speed of transmission, and accomplish with a single synchronous motion more than would be accomplished by a single connecting-roller and a single style, I divide the arc of the circle in which the plates, studs, or pieces are placed into five divisions, four of which are synchronously equal, one of which is greater than the others, for purposes shown herein; and in one of these divisions I arrange the plates, studs, or points, leaving the remaining divisions blank, or practically the plates, studs, or pieces are placed in what is something less than one-fifth of the arc of a circle. I also employ the same number of connecting-rollers, placed relatively the same, and all connected together, so that when one roller has made contacts with the plates, studs, or pieces, and leaves the last one of them, the next roller is making contact with the first of them, excepting in the case of the single unequal division, and thus five series of contact are made at each synchronous motion, and the speed of transmission is thereby greatly increased, as there is apparently a limit to synchronous motions.

In the receiving apparatus there must be as many recording-styles electrically connected together, and placed relatively the same, as there are contact-rollers in the transmitting apparatus which make connection with the plates, studs, or pieces connected to the transmitting-points, so that as one is leaving the chemically-prepared paper another is coming upon it, and so on.

I do not limit myself to the employment of five connecting-rollers and five receiving-styles; a greater or less number may be employed. The indefinite number of transmitting-points or styles passing over the message to be transmitted are, of course, arranged in the arc of the same circle as is described by the five receiving-styles; otherwise the message received will be distorted.

The vibratory or semi-rotary, not longitudinal, motion of the message-transmitting and the chemically-prepared paper is graduated so that the fine receiving-styles shall draw longitudinal lines of the requisite fineness upon the chemically-prepared paper on the receiving-drum.

When the electrical current can pass through a transmitting-style and the transmitting connecting-roller is bearing upon the plate, stud, or piece connecting with that style, an impulse is sent through the line-wire, and the receiving-point upon the chemically-prepared paper effects a discoloration at the place upon which it may be bearing at that instant. In this manner the message is recorded in fac-simile at the other end of the line. It will be observed that, owing to the vibratory or semi-rotary motions, of the transmitting and receiving drums, the receiving-styles, after the first of these motions, will pass over the partially-discolored paper in what are practically the same lines, at each passage, however, discoloring when impulses are received in fresh spots, because the receiving-drum is moved longitudinally, the same as the transmitting-drum, until finally the entire message is recorded. The principle of moving a style longitudinally over a drum in the arc of a circle may be applied with advantage to the automatic system of telegraphing.

The message to be transmitted is written upon a surface containing a tin, silver, or other metallic composition, which will readily absorb the insulating-ink in which the message is written.

My invention includes two kinds of insulating-ink—one a solution of silicate of soda, the other a mixture of gum-arabic, or similar gelatinous or resinous substance, and bichromate of potash properly colored. I do not propose,

however, to only write the message in insulating-ink upon a metallic surface, but also the writing of a message upon a special white or ordinary paper, and transferring the lines of writing to a metallic surface lithographically, or by fixing the paper upon the metallic surface and by washing with an acid, alkali, or other agent, destroying either that portion of the paper which is blank, or that portion which is covered by the lines of writing.

It is obvious that the insulating character of what is left upon the plate may be heightened or increased in various ways—by sprinkling, for instance, with some resinous substance, and subjecting the plate to heat.

For preparing the chemical paper upon which the message is received I use two sensitive processes. In one I saturate the paper with a solution of iodide of ammonia, rock-salt, and starch-paste. In the other I first thoroughly impregnate the paper with a saturated solution of rock-salt, when it is sun-dried. I then saturate it with a solution of starch-paste, very thin, rock-salt, and ferrocyanide of potassium. Any tinge of color on the ground of the paper, and every portion of chemicals, I remove from the received message by a water-bath.

When desirable to repeat or retransmit a message from the received message, I first change the nature of the prussian-blue deposit, as by a bath in a solution of caustic potash, fix the blank to a metallic surface, and, by washing with a solution acting upon the changed deposit or upon the white ground, I destroy either that portion of the paper which is covered by the lines of writing or the white ground.

One of the great difficulties experienced in copying-telegraphs is the difficulty of obtaining a perfectly synchronous movement, for which my invention especially aims to provide.

The motive power is applied directly to the shaft of the commutator, instead of through the medium of a train of gear-wheels; and in order to secure the utmost rapidity of action I make application of compressed air upon the turbine-wheel principle. The air is constantly forced into a storing-chamber, provided with an escape or waste valve capable of regulation, so that the force required may be regulated at each station to correspond with the operation of the instruments at the principal station, and all that is required is that the air shall be supplied in sufficient quantities to keep the valve continually raised and the air escaping. Thus a uniform force of compressed air is supplied by means of conducting-pipe to apparatus carrying the connecting-rollers of the transmitter and the recording-styles of the receiver. Secondary air-chambers may be used to secure greater uniformity of pressure.

At a certain point on the revolving apparatus is fixed a projection or detent, in the path of which, as it is carried around, is the detent-armature of a permanent magnet, which armature is wound with wire. While the connecting-rollers of the transmitting apparatus are making contacts with the plates, studs, or pieces connected with the points or styles upon the message to be transmitted, or while the receiving-styles are upon the chemical paper, the line-current is cut off from the armature-coil, and the permanent magnet holds the detent-armature within the path of the above-mentioned projection, so that motion of the apparatus is arrested by contact when the projection comes round; but just previous to this contact one end of the armature-coil is connected to the line-wire, and the contact of the projection with the detent-armature grounds the other end of the coil, and a circuit through the armature-coil is established, when, by reversal of polarity, the armature flies off, releasing the apparatus, and another revolution ensues. The instruments at each end of the line are therefore kept in perfect synchronism, as neither can start until both have arrived at the same point, and both must stop at the end of each revolution.

The motion is intermittent, but practically continuous. In order to avoid the jarring of a sudden stop, as soon as the fifth connecting-roller leaves the plates, studs, or pieces connected with the styles upon the message, or the fifth receiving-style passes from the chemically-prepared paper, the direction of the air is reversed, flowing in increased volume, and at the instant the projection touches the detent the primary action is restored; but the flow in one or the other direction is never arrested.

One of the great objections to chemical telegraphs is the difficulty of rapid transmission through long circuits, this being the case especially with the automatic chemical telegraph, in which the preparation of the message by perforation of paper fillets is rendered necessary in rapid work for every repetition or retransmission. The same objection applies to the copying-telegraph, and it is this difficulty which I have endeavored to practically overcome. To accomplish this I employ either one of two methods, which I will proceed fully to describe, the first founded upon the fact that the voltaic arc or electrical spark or electrified atmosphere are themselves conductors of electricity.

The current upon the first circuit grounds through a series of electro-magnets, the armatures of which are also wound with wire, forming a local circuit. Rapid revolutions of the armatures or magnets, upon the principle of ordinary magneto-electric batteries, cause the first-line current to induce a stream of electricity in the local circuit of the armature-coils, which streams of electricity may produce sparks or electrify the atmosphere, or make non-conducting substances conductors at breaks in the said local circuit.

In the drawings, for convenience I have shown a single armature and magnet. The second circuit, or line upon which the message is to be repeated, is broken between the re-

peating-battery and the earth, the separation being just sufficient to answer the purpose. To the ground end of the second line-wire is attached one end of the local magneto-electric armature-coil, the other end of the coil passing to, but being sufficiently separated from, and therefore not in connection with, the opposite wire of the second line-circuit just above the point of disconnection of the second line-wire, between the battery and the earth, and next to the battery. The intensity-current established in the local armature-coil will therefore leap the distance between itself and the end of the second line-wire, between the battery and the earth, and next to the battery, and, passing through the portion of the second line-wire between the point leaped and the point of disconnection of the second line-wire to the earth-wire, it will also leap that space, and thus establish its circuit, the voltaic arcs, sparks, electrifications, or conductors created by the local intensity-current serving, in two directions, to put the second-line battery to earth, and therefore upon the line. The same process may be repeated upon an indefinite number of circuits.

The second method consists in the use of an induction-coil, the primary and secondary wires of which may be equal or dissimilar. The secondary coil, as it may be termed, is placed at the beginning and in the circuit of the second line-wire, near the battery, the second line-wire being grounded indefinitely of the first line-wire, and the battery being constantly grounded near the ground of the second line-wire, but outside a resistance and this ground there is connected to it a contact point or roller, which makes connection with a rapidly-revolving drum or disk, which is divided into metallic and insulating surfaces, plates, studs, or pieces, so that electrical connection is constantly being made and broken. To this revolving drum is attached one end of the primary coil of the induction-coil, the other end of the coil being grounded. Thus, when the roller attached to the first line-wire is in contact with one of the metallic surfaces of the drum, the current is diverted through the primary coil of the induction apparatus, and upon its cessation a strong current of opposite polarity is generated by means of the secondary coil in the second line-wire, thus entirely neutralizing or equalizing, for the instant, the battery upon the second line-wire, so that it shall produce no effect at its other end.

It is obvious that the second-line battery may be dispensed with, the repetition being by induction only.

In working chemical telegraphs, a great obstacle to rapid transmission has arisen from the fact that the lines become surcharged either by the battery-current or the extra-induced or earth-current. Practically, an electrical impulse sent from one end of a line is lengthened at the other, and produces an effect of greater duration than the duration of connection or disconnection by which the impulse was transmitted, thus causing many impulses transmitted in rapid succession to produce the same visible effect at the receiving end of a line as would a single impulse of the same duration as the time occupied between the beginning and end of the many impulses, whereby dots become lines, or the received message is exaggerated or indistinct.

One of my principal methods of obviating retardation is comprised in the induction-coil apparatus above described as my second chemical-telegraph repeater. Its application, both as a repeater and line-clearer, is clearly shown in the drawings; but I will proceed to describe it briefly. The induction apparatus is placed at the receiving-end of the line-wire, the secondary coil being in the circuit. Between the coil and the receiving-instrument is placed a resistance exceeding the resistance of the primary coil. Between the secondary coil and the line the contact point or roller is attached to the line-wire, and the revolving disk or drum is attached to one end of the primary coil, the other end of the primary coil passing to earth. The contacts are made with great rapidity and continuously. When the roller is in contact with the drum the electrical impulse from the transmitting end of the line is diverted to earth through the primary coil, thus forcing the primary coil to act, even though the different impulses transmitted should run into each other so as to form a continuous electrical charge, and when the contact is broken and the primary coil out of circuit a discharge of opposite polarity to that producing the record is sent through the whole line.

Having thus described the principles, nature, and purposes of my invention, I will now describe the construction and arrangement of circuits, in order to enable those skilled in the art to make and use my improvements, reference being had to the accompanying drawings forming part of this specification, in which—

Figure 1 is a top view, showing the general arrangement of the transmitting and receiving apparatus. Figs. 2 and 8 are side views of the commutator, partly cut out, the motive power and synchronous attachments, the receiving apparatus, and the centered connector for operating the electro-magnets, which in part occasion the vibratory or backward and-forward motion of the transmitting and receiving drums. Fig. 3 is a sectional view of the motive wheel or band, showing the valvular application of the compressed air. Fig. 4 is a top view of the same, partially broken off. Figs. 5 and 6 are front and side views of the appliance for giving longitudinal motion to the transmitting and receiving drums. Fig. 7 is a side view of the apparatus for giving the vibratory motion to the drums. Fig. 9 shows the application of a single transmitting-roller and single recording-style. Fig. 10 is a view of the double coil and contact-breaker for line-clearing. Fig. 11 is a view of the magneto-

electric repeater. Fig. 12 is a view of the induction-coil repeater.

Referring to Fig. 1, A is the air-chamber; z', the escape-valve rod, and w the sliding weight. B is the metallic band or wheel, carrying the metallic contact levers and rollers $r\ r\ r\ r$ of the commutator. The metallic plates or studs n $n\ n\ n\ n$ upon the hollow insulating-periphery I, which is stationary, complete the commutator. Connected with these are the metallic styles P, insulated from the standard and each other, which make connection with the metallic paper z, running over the metallic transmitting-drum and under the friction-rollers $fr\ fr'$. B b is the motor cross-piece, better shown in Figs. 2 and 3. d is the projection upon and insulated from B, which engages with the detent-armature e' of permanent magnet E, thus arresting the revolution of B. S' y^1 are the metallic rollers, insulated from the frame, for changing the main circuits, y^1 being partially cut away; q, insulated metallic plate, stud, or strip, connected to d, and better shown in Fig. 8. F is the frame. K K K K K are the metallic levers, carrying the metallic recording-styles longitudinally across the chemically-prepared paper y, which runs from the reel y^2 over the receiving-drum and under the friction-rollers $fr\ fr'$. Sh is the shaft, fixed to the frame, upon which the drums may be turned, and upon which the drums, with the frame-work $x\ x'\ o$ and friction-rollers $fr\ fr'$, rock or vibrate. u u are standards. L L are paper-reels; $b\ b$, standards, and L b shaft upon which reels turn. h is a double pulley, from which a belt passes to shaft of B, and to pulley h', attached to gear-wheel gr, which meshes into gear gr', fixed to shafts, and thus gives motion to friction-rollers T^1 and T^2, fixed to same shafts, which alternately, according to the vibratory motion of the rocking frame M M, impart their motion to friction-roller T fixed to shaft sh. hs is the standard of pulley h. $m\ m$ are electro-magnets, which actuate the rocking frame M M. C' is the mechanism for imparting longitudinal motion to the frame-work, carrying the transmitting and receiving drum-shaft sh and friction-roller T; $m\ n$, electro-magnet which operates the same, better shown in Figs. 5 and 6. The friction-rollers fr' revolve upon the rod x, which is fixed to cross-pieces of frame o. The friction-rollers fr are fixed to the rod x^1, which turns in the cross-pieces o, thus enabling the operator to move the paper over the drums from the reels y^2. e e is the arrangement for operating the magnets $m\ n$ and $m\ m$, better shown in Fig. 2. $s\ s\ s\ s$ are switches; $g\ g\ g\ g\ g$, the studs to which they are moved. To binding-posts 1 and 2 are attached the poles of a local battery, to operate the mechanism c^1. 3 and 4 are binding-posts for local battery, to operate the magnets $m\ m$. To post 5 is attached the line-wire. To post 6 is attached the positive pole of line-battery, while to post 7 is attached the negative pole and a wire to earth.

The arrangement of wires in the drawing will be readily understood from the above positions.

When the instrument is transmitting, the wire from post 7 passes to shaft sh, connected with the transmitting-drum wire; from post 6 passes through switch to roller y^1, beneath roller s'. The battery, therefore, when the local circuit is uninterupted, passes from post 6 to y^1; thence through y^1 roller to metallic rim B; through B and commutator-roller r to studs n; thence to transmitting styles or rollers P, and thence, through metallic paper z, drum and shaft sh, to post 7, forming a local short-circuit.

When this circuit is interrupted by the insulated portions of the message, the battery is thrown upon the line, when the circuit will be from earth to post 7, and through battery to post 6; thence through switch to connecting-roller y^1; thence, by means of metallic rim B, to connecting-roller s', and to line through post 5.

When the detent d comes into contact with detent-armature E', the battery is cut off from roller y^1 by the insulated piece p, clearly shown in Fig. 8, where B is revolving rim; B b, air-mechanism cross-piece; d, detent insulated from B; and q, metallic strip connected with detent d, but also insulated from B, and the circuit is formed as follows:

From the line to post 5, to roller s'; thence through strip q to detent d and armature E', one end of the coil of which is connected to armature mechanism; thus through armature-coil to switch, turned so as to connect with wire to post 6, and thence through battery to post 7, and to earth.

When a message is being received, the circuit is from post 5 to roller s'; thence through rim and shaft sh' (better shown in Fig. 2) to rim K', Fig. 2; through recording-styles K, chemically-prepared paper, drum and shaft sh, to post 7 and earth.

When the detent d engages with armature E', the circuit through the drum is broken, and is as follows: Line to post 5, roller s', strip q, detent d, armature E' coil, and from armature-coil, through switch, to post 7, and earth. The changing of the switches will be understood from the foregoing explanation.

In Fig. 2, P' is the pulley, fixed to the shaft sh', which drives the double pulley h, Fig. 1; F, frame; E, permanent magnet; E', electro-magnetic armature of same; S', main-line roller; T^1, short-circuit roller; d, detent; s and g, switches and studs; A, air-chamber, from which tube or pipe D conveys air to hollow insulating-disk I, fastened to frame, upon the periphery of which are commutator-plates n; r, commutator-rollers; B, metallic commutator-rim fixed to shaft sh'; B b, cross-piece, in which air is conducted to smaller propelling-orifice v as actuated, and to the receiving-orifice v^1; K', disk or rim carrying recording-styles, and fixed to shaft; Dr, drum; $fr\ fr'$, fric-

tion-rollers; *o*, cross-piece of vibrating frame-work, which are the same in both transmitting and receiving portions of the apparatus. *e e* is the standard of the mechanism for operating the magnets *m m*, consisting of a vibrator, *m'*, electrically connected with standard *e e*, and actuated by the up-and-down motion of the friction-roller rod x^1, which drives the vibrator against the points *c c c*, which are insulated from the standard *e e*.

By reference to Fig. 1 it will be seen that one end of the wire from the magnet *m* under friction-roller T^1 passes to the upper point *c*, and one end of the wire from magnet *m* under friction-roller T^2 passes to the lower point *c c*, the other ends of the magnet-wires being joined, and passing to post 4, which is attached to one pole of local battery, the other pole being attached to post 3, and passing thence through switch to vibrator, so that by the action of the rod x^1, Fig. 2, on the vibrator, the battery is thrown alternately into the magnets *m m*, which in turn cause the vibratory motion of the transmitting and receiving drums and frame-work. The motion of the rod x^1, Fig. 2, is also used to operate the magnet *m n*, one end of the coil of which passes through switch to the vibrator or its standard *e e*, and the other end through battery, by means of posts 1 and 2, to rod x^1, so that every time in its upward or downward motion the rod x^1 comes in contact with the vibrator *m'*, a circuit is not only established through magnet *m n*, but also through one of the magnets *m m*.

In Fig. 3 are shown the interior and valvular arrangements of the propelling mechanism. F is the frame-work broken off; I, hollow disk, into which air is conducted by pipe D, Fig. 2; *sh'*, shaft. *v* is the propelling air-passage; v^1, the reversing. J is the opening through which the air passes from the interior I to the sunk portion v^2 of Fig. 4, where the disk I is shown partially cut away, D being the mouth of the air pipe or tube, Fig. 2. It is therefore apparent that the air will pass constantly into the sunk portion of I, v^2, Fig. 4, and for nearly a revolution will pass through J' to *v*, Fig. 2, as the valve J' is the nearer the shaft *sh'*, and that when this passage is interrupted by the shape of the sunk portion v^2, Fig. 4, the air will flow through J, which is the farther from the shaft *sh'* in the opposite direction, and, although of short duration, is of much increased volume as to check the speed and arrest the revolution of B, *sh'*, B, and K'.

Figs. 5 and 6 are front and side views of the longitudinal-motion mechanism, in which *sh* is main shaft of transmitting and receiving drums. c^1 is a disk or wheel, having an endless groove, a^2, on its periphery, which, starting from one side, passes to the other side in going half round, when it returns to the starting-point. U is a ratchet-wheel attached to the disk. c^2 is the shaft fixed to standard Se. *m n* is the electro-magnet, of which G is the armature, attached to curved spring-lever H, which is fixed to standard, and works pawl C in the teeth of the ratchet U. N is a projection working firmly in the groove a^2, and held perpendicular by a slot in the top of the standard Se, in which plays the projection O. *e' e'* are washers fixed to shaft, by which the movable washer x^2, with projections N and O, is kept in place upon the shaft. At every operation of the magnet *m n* the pawl will move the grooved disk the extent of one tooth in the ratchet, and the shaft *sh*, with transmitting and receiving cylinders and attachments, will receive a longitudinal movement, which continues in one direction until the disk has made half a revolution, when the direction of the movement changes, and vice versa. Upon the number of teeth on the ratchet depends the fineness of the lines drawn by the transmitting styles or rollers P, Fig. 1.

In Fig. 7 is presented a view of the mechanism by which the vibratory movement is imparted to the drums and frame-work. D*r* is the transmitting-drum; *o*, frame-work; *fr fr'*, friction-rollers; P, transmitting styles or rollers; *sh*, main shaft, which slides in standard *u*, and upon the end of which is fixed friction-rollers T. M M is the rocking frame, working upon a rod from standard *u*, and carrying the two friction-rollers T^1 and T^2, fixed to shafts, upon the ends of which are the gears *gr* and *gr'*, Fig. 1. G' G' are the armatures of the magnets *m m*, also carried by rocking frame. As the magnets alternately act and bring the friction-rollers T^1 and T^2 against the friction-roller T the vibratory or semi-rotary motion of the transmitting and receiving drums with their frame-work is obvious.

Having shown and described the method, preferably for speed, of placing the plates *n* in one division of the disk I, and having a number of contact-rollers, *r*, making connection with the plates *n*, so that by one passage of the rollers *r* around the disk several series of contacts are made with the plates, and having also shown the employment of the same number of recording-styles K in the receiving apparatus as there are rollers *r* in the transmitting apparatus, I indicate in Fig. 9 the operation of but one recording-style in the receiving apparatus.

Instead of the plates *n* being grouped in a division of the disk I, as when more than one contact-roller *r* is used, the plates are extended around the disk, and but one contact-roller *r* is used.

P are the transmitting-styles connected to plates *n*, and bearing upon drum D*r*. In the receiving apparatus K is the recording-style bearing upon drum D*r*. While the roller *r* is passing once over the plates *n* the style K passes once across the drum D*r*. I only indicate what would thus be a more difficult operation than where a greater number of rollers *r* and styles K are used, for the purpose of more clearly showing the function of

my invention. The operation is simple and easy, however, when the recording-style K passes around the drum D*r*, instead of longitudinally across it. Fig. 10 shows plainly the method of constructing induction-coil and circuit-diverter, both for line-clearing and repeating. R is the holder of a roller, which makes connection with the rapidly-revolving drum D when the metallic portions of the periphery of the drum are beneath it. The periphery of the drum is divided into insulated and uninsulated portions, as shown by the black and white spaces in the drawing. The semi-dotted line represents the secondary coil or line-wire, the unbroken line the primary coil. E E are earths. R*g* is the receiving apparatus; *x*, a resistance between the apparatus and coil

In Fig. 12 is shown the method of applying this coil and circuit-diverter to repeating purposes. T is the transmitting apparatus at the beginning of the first line-wire; B*y*, battery; E E, earths; *x*, resistance; R, contact-roller; and D, drum, by which the line-current is diverted through the primary coil of the induction apparatus. The second line-wire, upon which the message from T is to be repeated, passes from earth E through battery and secondary coil; thence to receiving apparatus R*g* and earth E. Fig. 11 shows the magneto-electric repeater. *m* is a magnet, charged by first-line battery; *a*, revolving armature; E E, earths. The local magneto-electric circuit is broken at *b* and *c*, over which breaks, though infinitely slight, the induced current must pass to form the local circuit. B*y* is the battery of the second line-wire, upon which the action of the first is to be repeated. The second line-wire is broken at *b*.

Having thus fully described my invention, what I claim as such, and desire to secure by Letters Patent, is—

1. The combination, with a main line, of a series of transmitting-styles, a commutator, by which the transmitting-styles are brought into circuit *seriatim*, and one recording-style, substantially as set forth.

2. The combination of a main line, a series of transmitting-styles, a commutator, and one recording-style.

2½. In a chemical telegraph, the combination, with transmitting apparatus, comprising a series of transmitting-styles and a commutator, of a receiving apparatus having but one recording-style, which distributes the impulses gathered into circuit by the commutator.

2¾. The method of signaling and recording signals, consisting of concentrating into the line at the transmitting end, by means of a commutator, the impulses proceeding through a series of transmitting-styles, points, or rollers in certain relative positions, and distributing said impulses at the receiving end by relatively changing the positions of the recording or marking style or styles during the passage of said impulses, so as to deposit an impulse at the same relative point upon the receiving-paper as the transmitting-style from which such impulse proceeded occupied upon the message transmitted, by which means the commutator and recording-styles at the receiving end corresponding to the transmitting commutator and styles are avoided.

3. The combination of a main line, a series of transmitting-styles, a commutator consisting of a series of contact pieces or rollers in groups or divisions, a function of which series, groups, or divisions is to place the transmitting-styles in circuit *seriatim*, and one recording-style for each such series, group, or division, substantially as shown and described.

4. The combination, with a line of a receiving apparatus in which the recording style or styles pass across the sheet, strip, or roll of receiving-paper, each style moving in one direction, instead of vibrating back and forth, thus drawing actual or imaginary lines across the sheet, strip, or roll of paper, instead of lengthwise of it, substantially as set forth.

5. The combination, in a receiving apparatus with one or more recording-styles, of mechanism for giving the style or styles a continuous motion, or a motion in one direction transversely of the paper upon which the message is recorded, substantially as set forth.

6. The combination, with mechanism for imparting motion to transmitting or receiving apparatus, of an air-receptacle and valvular passages for the purpose, first, of driving the mechanism, and then of checking or bringing it to a stop, substantially as shown and described.

7. The combination, with the metallic drums and their shaft, of a cam for producing a longitudinal reciprocation of the drums, as set forth.

8. The combination, with the metallic drums, of the rocking frame, the electro-magnets, and circuit-connections, for giving a reciprocating rotary motion to the drums, as set forth.

9. The combination, with the metallic drums and their shaft, of the rocking frame, the electro-magnets, and circuit-connections, and a cam for giving a simultaneously longitudinal reciprocating and reciprocating rotary movement to the drums.

10. The combination, with a main line and its battery, of an induction or an electro-magneto electric apparatus, the current induced by which serves to electrically bridge a break or lessen a resistance in the circuit in which it flows, as set forth.

11. In a chemical or copying telegraph, the method of obtaining an insulating writing-surface upon a metallic surface, consisting of transferring the lines of writing first formed in a prepared ink upon paper to a metallic surface lithographically, or by fixing the paper to the metallic surface, and washing off from the metallic surface either that portion

of the message-paper which is blank, or that portion which is covered by the lines of writing, as set forth.

12. The method of treating the received message, consisting of subjecting the paper to a bath, and thus removing any discoloration excepting the electrolytic discolorations, as set forth.

13. The combination of a line with an induction coil or coils and a mechanical circuit-changer, for the purpose of clearing a line of tailings independently of the transmitting apparatus or process, substantially as shown and described.

The above specification of my invention signed by me this 15th day of October, 1874.

W. E. SAWYER.

Witnesses:

CHAS. A. PETTIT,

SOLON C. KEMON.