(No Model.) 2 Sheets—Sheet 1.

J. H. ROBERTSON.

WRITING TELEGRAPH.

No. 543,425. Patented July 23, 1895.

Fig. 1.

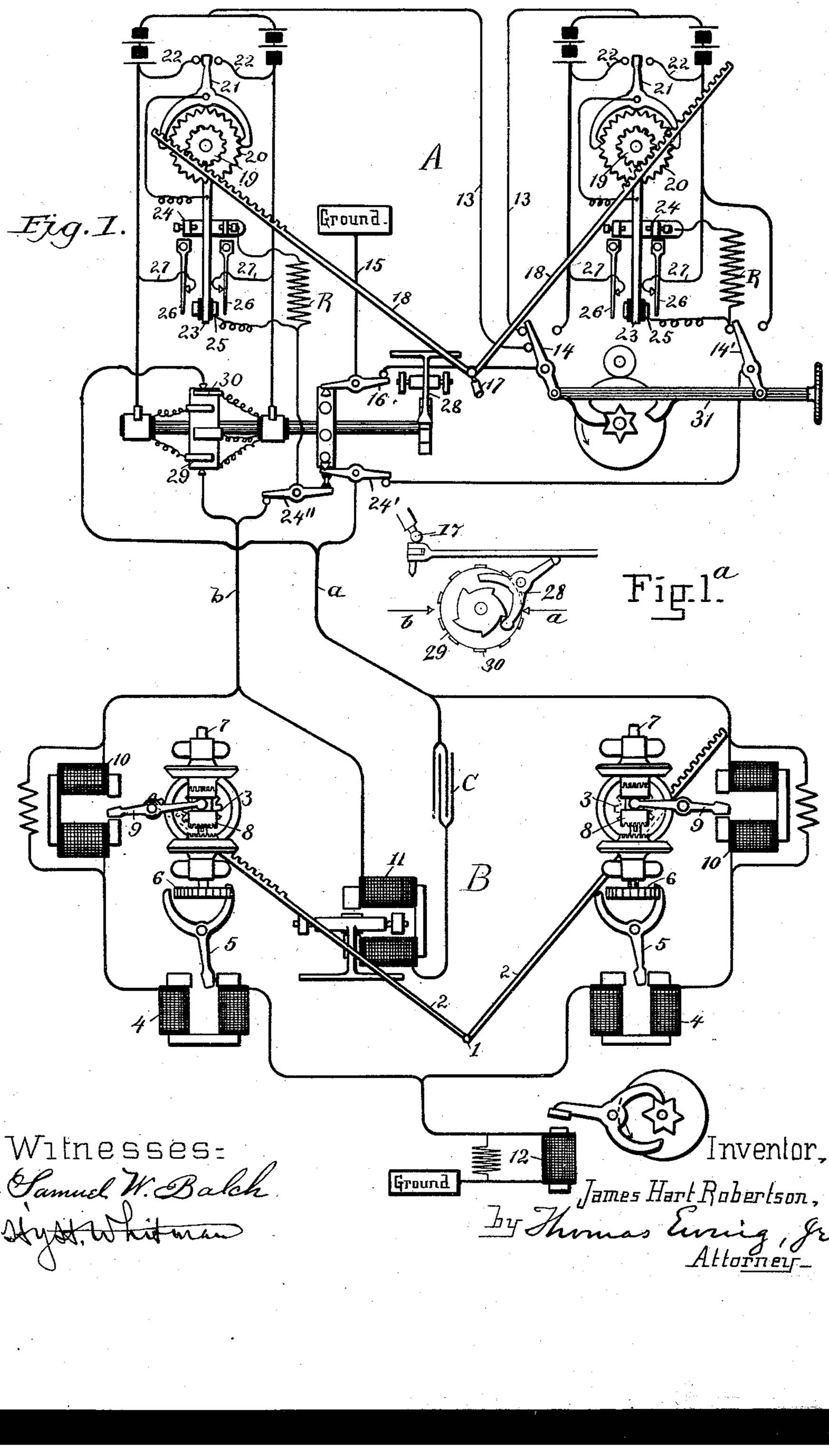

Fig. 1a

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

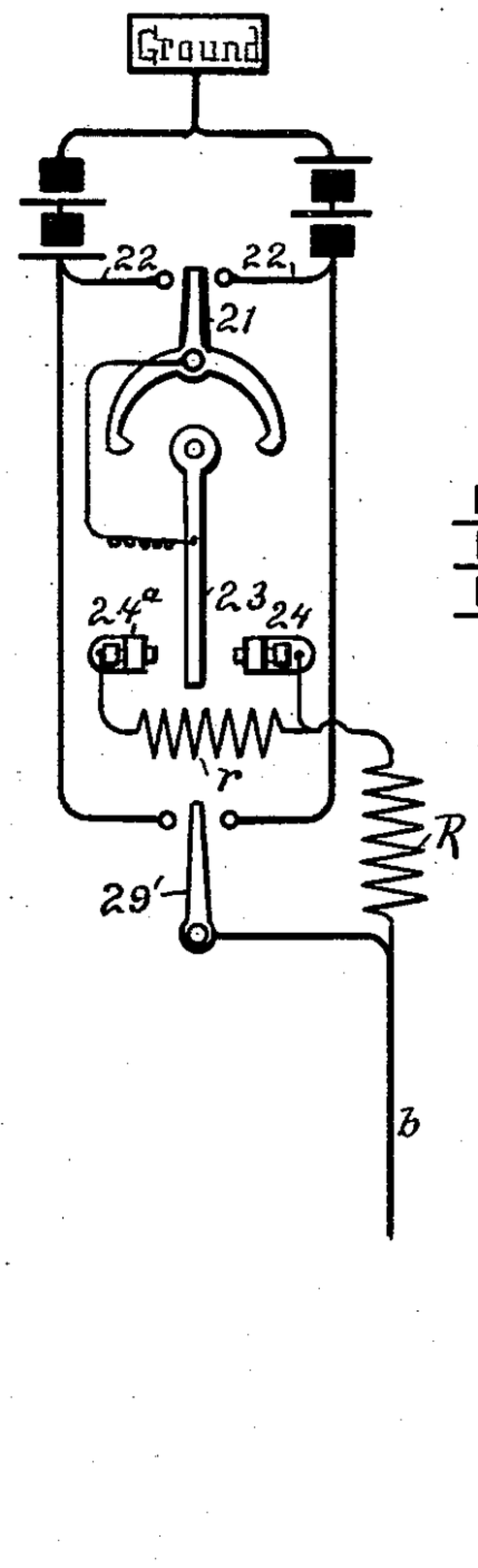


Fig. 3.

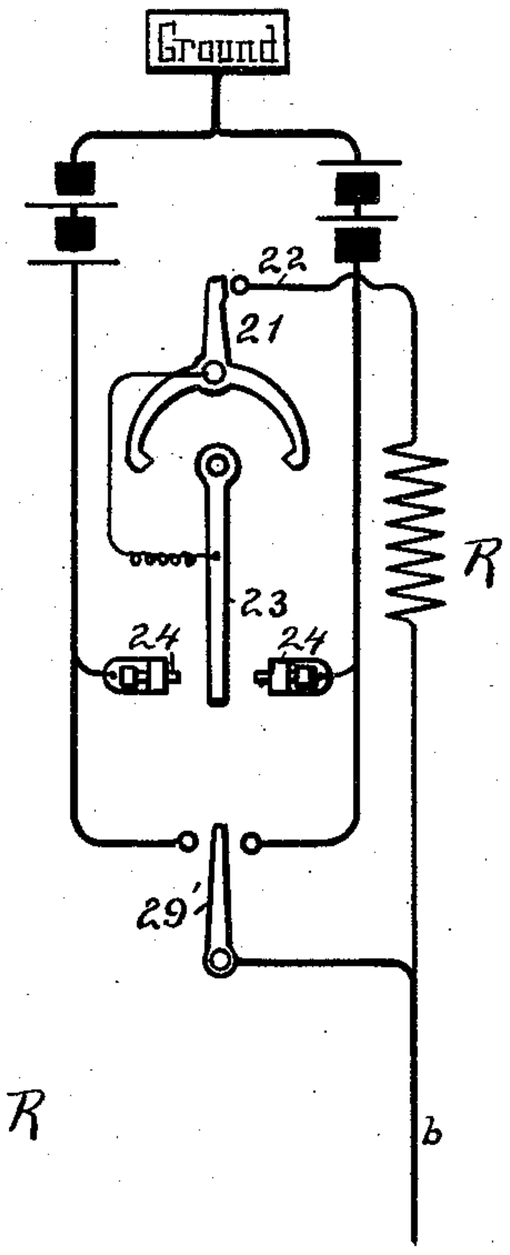


Fig. 4.

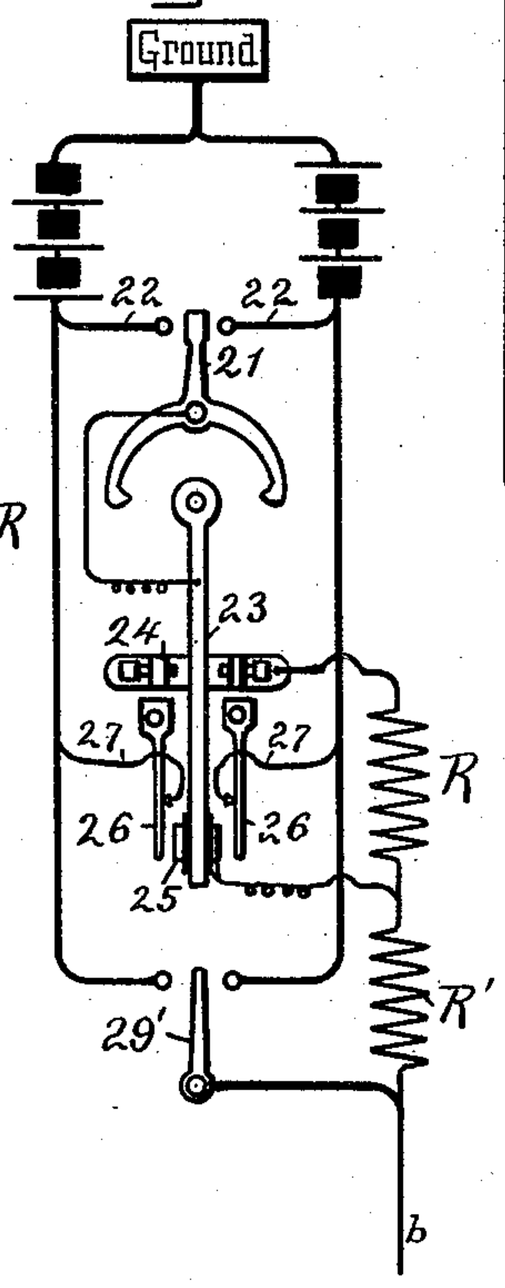
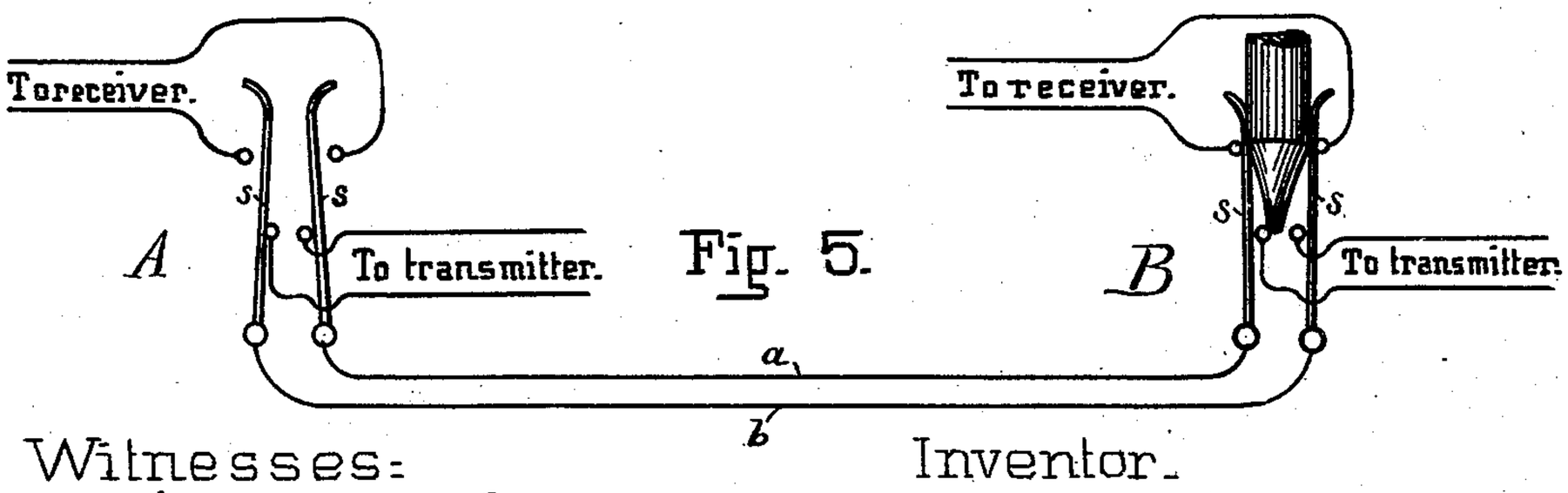


Fig. 5.



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UNITED STATES PATENT OFFICE.

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WRITING-TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 543,425, dated July 23, 1895.

Application filed January 9, 1894. Renewed December 24, 1894. Serial No. 532,891. (No model.)

To all whom it may concern:

Be it known that I, JAMES HART ROBERTSON, a citizen of the United States of America, residing at Brooklyn, county of Kings, State of New York, have invented certain new and useful Improvements in Writing-Telegraphs, of which the following is a specification.

I have herein described a two-wire writing-telegraph system—*i. e.*, one in which the transmitter and receiver stations are connected by two wires only.

My complete invention consists of a two-wire system in which the fundamental telautographic operations of moving the pen and controlling its direction of movement, of lifting and lowering the pen, and of shifting the paper at the receiver, are effected by actual currents transmitted over the lines by the operation of the transmitter and not by a mere cessation of transmission of currents over either or both of the lines; and my invention further consists in a system of commutation whereby it is possible when operating over two lines to transmit to these lines different sets of currents to effect these different results at the receiver-station, which different sets of currents shall include currents of both polarities; and my invention further consists in a system of writing-telegraph in which the operation of the receiver-pen in the plane of the paper, or in a plane parallel thereto—*i. e.*, its operation in writing or in positioning the pen—is controlled by polarized magnets, the movements of the receiver-pen being effected by alternating impulses sent to line by corresponding movements of the transmitter-pen, and the direction of the movements of the receiver-pen being controlled by currents of both polarities, which currents intervene between the set of alternating impulses to effect the movements of the receiver-pen, and are sent to line whenever the direction of the transmitter-pen is changed. These intervening currents are preferably stronger than the alternating impulses that control the movements of the receiver-pen; and my invention further consists in a transmitter so organized that the movements of the transmitter-pen in writing or in positioning will cause such currents to be sent to line, and of a receiver so organized that under the influence of such currents the receiver-pen will follow the movements of the transmitter-pen both as to extent and direction of motion; and my invention further consists in certain details hereinafter specifically described and claimed.

General Operation.

The movements of the transmitting-pen in the plane of the paper are resolved into two components by attaching to the pen two bars placed at an angle preferably nearly at right angles to each other. The bars in moving forward and back operate transmitting mechanism, which sends currents that move similar bars attached to the pen of the receiving-instrument. The mechanism operated by one of the component bars at the transmitter sends its currents over one of the line-wires, and that operated by the other bar similarly operates to send its currents over the other line-wire. These two sets of currents sent independently of each other and simultaneously when required over the two line-wires effect the transmission of the movements of the transmitter-pen. The receiving mechanism responds to the currents and reproduces these movements at the receiver-pen. In addition two other classes of movements have to be effected at the receiver. One of them is the lifting and lowering of the receiver-pen and the other the feeding of the receiver-paper. To lift and lower the pen, there is sent from the transmitter extra-strong positive and negative currents over the two lines thrown into one circuit. To shift the paper, extra-strong currents are sent over one of the lines. At the receiver there must be suitable translating devices which, under the influence of these currents, lift and lower the receiving-pen and shift the paper. The pen is lifted and lowered through the medium of a polarized magnet which is connected with a condenser in a cross connection between the two lines. This polarized magnet is not operated by the weaker polarized currents that control the movement of the pen in extent and direction. The paper is shifted by a non-polarized magnet which is in a common ground of the two lines.

In the accompanying two sheets of drawings, which form a part of this specification,

Figure 1 is a diagrammatic view showing my transmitter and receiver and the manner of connecting them in the system. Fig. 1ª is a detail showing in side view the connection of the transmitter-pen and pole-changer. Figs. 2, 3, and 4 show, diagrammatically, modified arrangements for either side of the transmitter. Fig. 5 shows a switch operated by the pencil to shift the lines between the transmitting and receiving instruments at the stations.

Referring now to Fig. 1, it will be seen that it shows the transmitter of one station, which is herein called "station A," and the receiver of another station, which is herein called "station B," connected by two wires *a* and *b*. For simplicity, I omit to indicate in the drawings the manner in which the receiver of station A and the transmitter of station B are connected to the lines *a* and *b*. This is effected through a switch connected with the transmitter-pen holder, as indicated in Fig. 5.

Construction of the Receiver.

Electrically, the two sides of the receiver mechanism are evenly balanced. In each side is a polarized magnet, for controlling the direction of movements of the pen, and a shunt around it. These two magnets and their shunts are exactly alike. In each side there is also a polarized magnet for controlling the extent of movement of the pen. These two magnets are exactly alike. In front of these two pairs of magnets the lines *a* and *b* are connected by a loop, in which are placed in series a condenser and a suitable translating device—such as a polarized magnet—for controlling the lifting and lowering of the pen. This loop is disposed symmetrically with respect to the two lines. The lines *a* and *b* are joined immediately beyond the above-named two pairs of magnets and connected at their point of juncture with a grounded line in which is placed the paper-shifting magnet and a shunt around it.

The tracing pencil or stylus 1 is connected with two rods 2, which make at their common point of junction with the pen approximately a right angle with each other. The movements of these rods forward and back are controlled by two identical mechanisms, each of which with its rod is hereinafter termed a "half receiver."

In each mechanism the polarized pen-moving magnet 4 vibrates an anchor-escapement 5, and through the ratchet-wheel 6 rotates the shaft 7, on which two miter-wheels are loosely mounted. Each of these miter-wheels engages with a third, to which the pinion 3 is attached. The shaft 7 revolves in one direction only. A clutch 8 is splined to this shaft and may be made to engage with either of the two miter-wheels, and the one of these with which it is engaged determines the direction of revolution of the lower miter-wheel and of its pinion, and thereby determines the direction in which the rod will be driven. The clutch is shifted by the lever 9, which carries an armature controlled by the polarized direction-controller magnet 10.

From the foregoing it will be seen that the direction in which the rod of either mechanism moves is determined by the position of the armature of the direction-controlling magnet 10, and the extent of movement of the rod in either direction is determined by the number of oscillations of the escapement by the pen-moving magnet 4.

The pen-moving magnet 4 and direction-controlling magnet 10 are both polarized magnets, and some means must be provided for preventing the armature of magnet 10 from being operated by the ordinary currents which operate the magnet 4. To effect this I introduce a shunt across the leads of this magnet 10, which carries so much of the current around this magnet that it is not operated except when a quite heavy current is thrown into the circuit. This shunt also affords an excellent means of adjusting the polarized magnet.

The foregoing mechanism is sufficient if operated by suitable transmitting mechanism to cause the receiver-pen to follow the movements of the transmitter-pen, both as to extent and direction, in the plane of the paper in the operation of writing, and in a plane parallel to the plane of the paper in the operation of positioning the pen; but it is necessary in addition to provide certain supplemental devices, which by their operation effect fundamental telautographic movements, to wit: a device to lift and lower the pen and a device to shift the paper.

It will be seen from the following description that when a supplemental part is to be operated the currents which effect the horizontal movement of the pen both in extent and direction are suspended, so that the line is free for the transmission of currents which operate the supplemental device.

The pen lifting and lowering device of Fig. 1 consists of a polarized magnet 11, which is connected in the circuit by means of a loop between the lines *a* and *b* in any convenient location relatively to the magnets 4 and 10. A condenser C is connected in series therewith. To magnetize this magnet 11 so as to cause it to lift and lower the pen there must be thrown onto the line a current which will establish between the points on the lines *a* and *b*, to which the ends of this loop are attached, a greater difference of potential than is established by the currents that operate the magnets 4 and 10. I effect this by doubling the battery and connecting up one line with the positive end and the other line with the negative end. This condition must be maintained long enough to charge the condenser. The device for doing this will be described later. Whether the current thus transmitted is stronger than that sent over either line to change the direction of movement of the pen will depend upon the resistances of

the circuit. To shift the paper it is necessary to throw onto one of the lines, as *a*, a current of sufficient strength to operate the magnet 12. This magnet is not polarized. It is provided with a suitable shunt, so that it is not operated by the weaker currents which operate the magnets 4 and 10. The magnets 10 are subject to untimely operation. Both may operate on operating-magnet 11 and one may operate on operation of magnet 12. Whether these are operated or not will depend on the positions of the armatures relatively to the polarity of the current transmitted. Magnets 4 are subject to similar untimely operation, but if magnet 10 is operated the energization of the corresponding magnet 4 does not move the pen as the clutch is out of gear. The only effect of operating a magnet 4 once is to move the pen one unit of distance, which is trifling. The transmitter is so constructed that it will in the hands of an operator of any degree of skill correct the untimely operation of magnet 10 with magnet 11, as will be seen later. Magnet 12 is not subject to untimely operation upon the operation of magnet 11.

When the paper-shifting commutator is operated sufficient current may flow across the loop at the receiver, which includes the pen lifting and lowering magnet, to operate it; but the paper is never shifted in practice, except when the pen is already lifted off the paper. Therefore the polarity of the current which shifts the paper should be the same as the polarity of the current which lifts the pen on the line over which the current is transmitted to shift the paper.

It is obvious that the paper-shifting and pen lifting and lowering magnets of the receiver can be exchanged in position; but it would still be desirable to operate the pen lifting and lowering magnet by currents of both polarities and the paper-shifting magnet by currents of one polarity.

The Transmitter.

Each half of the transmitter must send over each of the two line-wires alternating pulsations to control the extent of movement of a rod of the receiving-pen, a distinct set of polarized impulses to control the direction of the rod in the corresponding halves of the receiver, and the transmitter must also send over suitable circuits a set of polarized impulses to lift and lower the pen and a set of impulses to shift the paper. The direction-controlling impulses intervene between the alternating pulsations which move the receiver-pen horizontally—that is, when the pens have been moved as far as is desired in one direction the alternating pulsations cease, a current is sent to set the direction-controlling mechanism, and then the alternating pulsations begin again.

The transmitter-pen by its horizontal movement sends the impulses that effect the horizontal movements of the receiver-pen. It is not feasible in practice to impose on the operator conditions respecting the position of the transmitter-pen at the time when it is lifted or lowered or when the paper-shift is operated, or when the direction of movement of the pen is reversed. Therefore with the apparatus and system shown it is necessary, in order to avoid short circuits, that these various sets of impulses be transmitted to line through distinct branches, and provision must be made to prevent the simultaneous closure of any two of these branches to the same line. The principle may be stated generally thus that where there are connected up to a line two branches through either of which positive and negative currents are sent to the line or through one of which positive currents are sent and through the other of which negative currents are sent by mechanisms operating independently of each other it is necessary, in order to avoid short circuits, that these two branches be not closed simultaneously. I believe that I am the first to apply this principle in a two-wire writing-telegraph system; and I believe that I am the first to devise a two-wire system in which all the various movements of the pen and paper are effected by actual currents and not by rupture of either or both of the lines. I make use of the two wires to transmit currents to lift and lower the pen and shift the paper at a time when they are not in use for any other purpose; and I believe myself to be the first to connect to a single line two or more branches, through any one of which positive and negative currents are sent to that line or through one of which positive currents are sent and through another negative by mechanisms which form a writing-telegraph transmitter and transmit currents that will effect the proper movements of the pen in the horizontal together with its proper movements in the vertical or with the shifting of the paper.

I believe I am the first to provide the pen-lifter and paper-shifter of the transmitter with the attachments operating to open the branches through which, in the operations of the transmitter-pen, are transmitted currents which control the horizontal movements of the receiver-pen.

In order to illustrate the foregoing principle I have shown several forms of transmitter taken from several of my pending applications, but somewhat modified. Thus in Fig. 2 I have shown the essentials of the transmitter claimed in my pending application, Serial No. 542,622, filed March 21, 1895. In this transmitter the pulsator sends alternating currents to line which are either strong or weak, according as the switch-arm 23 is closed against point 24 or 24^a, an additional resistance *r* being interposed between the point 24^a and the line, as indicated. There is a second switch-arm 29′ which connects either battery directly to line to lift or lower the pen. If in this system the alternating pulsator be closed, say, to the positive pole of the battery, and at the same time the switch

29′ be closed to the negative pole of the battery, obviously there will be a short circuit, unless the branch which includes the switch 23 and the alternating pulsator is open when the switch 29′ is closed.

If the alternating pulsator happens to be connected with the same pole of the battery to which the switch-arm 29′ is connected, then there will be no need of breaking the branch through the alternating pulsator, for in this case there will be no short circuit of the battery; but the operator when he closes the switch 29′ cannot in practice know whether or not the alternating pulsator is connected up to the battery or how it is connected up when he lifts or lowers the pen or shifts the paper, and therefore the branch through this pulsator must be broken.

Fig. 3 shows the essentials of my transmitter claimed in my application, Serial No. 542,621, filed March 21, 1895. This transmitter is constructed to send pulsations to line which are either positive or negative, according to the position of the switch-arm 23. The switch-arm 29′ in this figure is similar to 29′ in Fig. 2. The same remarks made above respecting short circuits in Fig. 2 apply to Fig. 3.

Fig. 4 is a detail of the same general plan as Figs. 2 and 3, showing the transmitter described and claimed in this application but simplified in order to make it easy to trace the short circuits which may arise in its operation. In this modification the currents sent are similar to those which are sent by the arrangement shown in Fig. 1, but in this arrangement the strongest currents flow from one-half of the battery only, instead of being taken from the whole battery in series, and additional resistances R′ weaken the currents sent to effect other results, so that they may be distinguished at the receiver.

I have stated as an essential condition to avoiding short circuits in these various transmitters that no two branches should be simultaneously closed through either of which positive or negative currents are sent to line or through one of which positive currents are sent and through the other negative by mechanisms operating independently of each other.

It is obvious that instead of breaking one of the branches a connection might be established between the pulsator and the switch 29′ of Fig. 2, whereby whenever the switch 29′ is closed through either side of the battery the pulsator will be closed to the same side of the battery, and in Fig. 3 whenever the switch 29′ is closed to one side of the battery the switch 23 may be closed to the same side of the battery; but to do this would effect no useful end, over merely breaking the branch, and if at the moment of operating switch 29′ the pulsator of Fig. 2 or the switch 23 of Fig. 3 happens to be connected up to the other side of the battery its transfer from one side of the battery to the other would involve breaking the branch. I therefore use the expression "breaking the branch" in this specification and in the claims, and any analogous expression thereto broadly to include any device which either breaks one of the branches or throws both of the branches to the same side of the battery.

The construction and operation of the transmitter will now be described. The two parts of the transmitter are connected with the corresponding parts of the receiver by separate circuits. Each of these parts of the transmitter consists broadly in a battery of cells connected in series, with an intermediate ground, a transmitter-switch operated through a connecting-rod by movements of the transmitter-pen in the horizontal, and a commutator, which, when operated, breaks the branches through the transmitter disk and switches, and connects the batteries to line, as hereinafter described. One of the commutators is mechanically attached to the paper-shifter and the other to the pen lifting and lowering device. The only difference between the two parts of the transmitter is in these commutators. They will be described later.

Pen-Mover.

The transmitter-pen, like the receiver-pen, is connected with two rods 18, on the ends of which are racks that engage with pinions 19. These transmitter-pen rods impart rotation to the pinions with which they engage instead of having motion imparted to them thereby, as is the case with the similar rods attached to the receiver-pen. Upon the same axes with these two pinions are toothed wheels 20, the teeth of which engage with pivoted anchor-pawls 21. The third arm of this pawl is a contact-finger, which, when the toothed wheel rotates, is thereby vibrated between two contact-points 22 22, connected respectively with the positive and negative ends of one of the batteries above referred to. The fingers of an anchor-pawl 21 and the contacts 22 22 constitute an alternating pulsator. This pulsator is electrically connected with a rod 23, which is frictionally mounted on the axle carrying the pinion 19. Frictionally attached to each pinion-shaft is a rod 23. This rod, when the shaft to which it is attached revolves, is thereby carried around until the rod bears against one of the contact-points which lie on either side of the rod, each point being electrically connected with the metallic shoe 24. As long as this contact is maintained the pulsator is connected to the resistance R. This connection is maintained without respect to the range of movement of the pen so long as its direction is not changed. Whenever the direction of motion of the pen changes the rod swings to the other side, and for a brief time disconnects the pulsator. Other currents are meanwhile sent to line.

From the foregoing partial description of the transmitter it will be seen that rotation of the transmitter-disks will cause alternating currents to be sent over both of the lines *a*

and *b*, which currents pass through the resistances R R and are diminished in strength thereby.

The complete circuit through the line *a* when it is grounded through the branch which includes the alternating pulsator is as follows: ground wire 15, switch 16, switch 14, wire 13, one-half of the battery, one of the points 22, finger 21, rod 23, shoe 24, resistance R, switch 14′, switch 24′, the shunt around magnet 10, magnet 4, and the shunt around magnet 12, to ground.

The complete circuit through the line *b* when it is connected with the branch, which includes the alternating pulsator, is as follows: ground wire 15, switch 16, switch 14, wire 13, one-half of the battery, one of the points 22, finger 21, rod 23, shoe 24, resistance R, switch 24″, line *b*, and the shunt around magnet 10, magnet 4, and the shunt around magnet 12, to ground.

Pen-Direction Controller.

On the outer end of each of rods 23 is a metallic cap insulated from the rod and connected to line ahead of resistance R. When either of the pinions connected with the transmitter-pen is rotated in either direction, the frictionally-attached rod 23 is moved to the right or left from the position in which it is shown in the figure. The effect of this is first to bring the insulated cap 25 on the end of this rod into contact with one of a pair of contacting-strips, (shown as springs 26,) which lie on either side of rod 23. These springs 26 are normally in contact with points 27, one of which is connected with one pole and the other with the other pole of the battery, but they are otherwise insulated from each other. As the pinion is still further rotated the spring with which contact is established is carried out of engagement with the contact-points 27 and the rod 23 is moved on into engagement with the metallic shoe 24, thereby establishing the connection from the pulsator to the resistance R above referred to; but at the first moment of contact of the insulated cap 25 with the spring 26 connection is established between the insulated cap and the contact-point in contact with the spring. This momentarily closes a circuit from the battery through the contact-point along the spring to the insulated cap and from thence to line. This circuit is exactly the same as heretofore traced, except that, as will be seen, the pulsator, shoe 24, and resistance R are cut out by breaking the branch through them at the shoe 24, and a branch is closed through one of the contact-springs 26 and insulated cap 25. The current which is thus forced to line for a moment whenever the insulated cap is brought in contact with either of the springs is of sufficient strength by reason of the cutting out of the resistance R to operate the magnet 10, this connection from one or other of the batteries through one or other of contact-points 27, spring 26, and insulated cap 25 constituting another of the branches to the line hereinafter referred to.

So long as the pen is moved in one direction the rod is kept over against the same spring and holds it away from its contact-point. The armature of magnet 4 is vibrated by the current sent through the pulsator, and the armature of magnet 10 remains in position to continue the motion of the receiving-pen in the same direction. So soon as the motion of the transmitter-pen is reversed at either rod 18, connected with the pen, the rod 23 is carried back out of contact with the spring 26, with which it has been in contact, and into contact with the other of the springs 26. This other spring, as will be seen, is connected with the opposite end of the battery and will send a momentary current through the cap and around the resistance of opposite polarity to that sent by contact with the first spring. This current will operate the magnet 10 and reverse the clutch, so that on further operation of the magnet 4 the direction of the motion of the receiver-pen will be reversed. It is of no consequence whether the transmitter-pen or the receiver-pen is resting on the paper or lifted above it. The movements of the transmitter-pen control the movements of the receiver-pen exactly in the same way in both cases. These two switches always operate in the same order whenever the arm 23 is moved in either direction from its neutral position. The branch through the insulated cap is first closed to line and then opened, and the branch through the shoe is then closed and remains closed until the direction of motion of the pen is changed. The two switches then operate in the reverse order—that is, the branch through the shoe is first opened and the branch through the insulated cap is closed, and on further movement of the pen is opened; but this reverse operation of the switches effects nothing and might be omitted.

The rod 23 and cap 25 constitute two mechanically-co-operating contact members electrically insulated from each other.

The foregoing transmitting devices are sufficient to control and effect the movements of the pen in extent and direction. The parts of the transmitter for operating the supplemental devices at the receiver—to wit, the device to lift and lower the pen and the device to shift the paper will now be described.

Pen Lifting and Lowering.

To lift and lower the pen I break the connection of one side of the transmitter with the line and break the ground connection of the other side of the transmitter and throw the two poles of its battery one to one line and the other to the other, thereby making of the two lines one complete metallic circuit.

The change in the circuit above stated is effected by merely lifting the transmitter-pen. One of the rods attached to this pen is connected with an anchor-escapement 28, which,

when the pen is lifted, rotates the shaft of the pole-changer 29 far enough to pass one pair of contact-strips 30 under the pair of brushes of the pole-changer. When this movement of the pole-changer has been completely made, the normal condition of the circuit is re-established, so that the receiver-pen when lifted is as completely under the control of the transmitter-pen as when it is down on the paper; but during the movement of the pole-changer the following changes of circuit are effected: The normal ground of both of the batteries is broken at switch 14 by breaking the connection between wires 15 and 13, and the branches to lines *a* and *b*, which include the alternating pulsators, are both broken at the switches 24′ 24″. The two ends of the leads from the battery are connected through the commutator-strips and contacting-brushes one with line *a* and the other with line *b*.

It is not necessary in order to lift or lower the pen to break the ground connection of the battery that is thus connected up to the two lines. The pen lifting and lowering magnet may be operated irrespective of whether this ground is broken or not; or, to state the point another way, the metallic circuit is the equivalent of two separate lines with batteries connected up to the two in opposite directions. Each arrangement makes substantially one circuit of the two lines; but practically less battery is required and a more reliable action is assured if the ground connection is broken than if it is not broken, and I therefore break it.

When the transmitter-pen is lowered the pole-changer shaft is again rotated in the same direction as before and far enough to carry the pole-changer around one more space. During its rotation this sets up exactly the same complete metallic circuit as before, except that the battery is connected with the line in the reverse position, so as to send a current to line of opposite polarity to the current used in lifting the receiver-pen, thereby effecting the lowering of the pen. This change of polarity will be clear when it is observed that on the pole-changer each alternate contacting-strip is connected with one pole of the battery and the intermediate strips with the other pole of the battery. The circuits and construction of the pole-changer can readily be seen from inspection of the drawings.

Paper Shifting.

To shift the paper a rod 31 at the transmitter is pushed in, thereby mechanically shifting the paper at the transmitter-station and at the same time so changing the circuits of line *a* as to actuate the magnet 12 at the receiver-station and shift the paper by the escapement mechanism shown. To accomplish this one pole of the battery on this side is connected to ground and the other pole is connected to line *a*, whereby it reaches the ground at the receiver-station. It might be connected to line *b* instead since this line is always out of use when the paper is shifting. When the switch 14′ is shifted resistance R is cut out, and there is sent through the shifting-magnet 12 a current of double the normal electromotive force and further strengthened by a reduction of resistance in line, whereby a current of sufficient strength to operate the magnet 12 is transmitted along the line. These changes in the circuits are effected as follows: When the rod 31 is pushed in the contact-switch 14 disconnects the lines 13 13 from the ground and grounds one pole of the battery through the switch 16 and wire 15. The other pole of the battery is switched on to the line *a*. The transmitter, including resistance R, is thus entirely cut out. The circuit is then, by line *a*, through magnets 10, 4, and 12 to the ground at the receiver-station.

The discussion given above respecting the short circuits, which may arise and must be provided against, will now be continued, with particular attention to the mechanism claimed in this specification. There is danger of cross connections through the different switches of each half of the transmitter, as above explained, and there is also danger of cross connections between the two batteries when one of the batteries is connected up to line either to lift or lower the pen or shift the paper. The possible short circuits in the half of the transmitter that is connected up with the pen lifting and lowering pole-changer will first be discussed, then the possible short circuits in the other half of the transmitter connected up with the paper-shifting commutator, and finally the possible cross connections between the two lines, with the ways herein adopted of avoiding them.

The connections from the battery through the pole-changer to lines *a* and *b*, or through the paper-shifter commutator to line *a*, constitute a third branch to line herein mentioned. The connection through the pole-changer between the battery and the two lines might, perhaps, more properly be called a "loop;" but I use the term "branch to line" broadly to cover either a loop between two line-wires or a grounded connection to one line-wire; and where in certain claims this pen lifting and lowering loop is included as a branch to line and only one line is specified in the claims, I do not mean to thereby exclude the idea of there being more than one line between the transmitter and the receiver stations. In the system shown, as already stated, no two of these branches can be closed simultaneously. If, for example, the first-described branch were closed at the contact between rod 23 and shoe 24 and through the alternating pulsator—say to the positive end of one of the batteries—at the same time that the second branch is closed, say, to the negative end of the battery through insulated cap 25 and one of springs 26 and contact-points 27 there would be established a short circuit

as follows: battery 22 21 23 24 R 25 26 27 battery. Therefore this branch through contacts 23 24 and 22 21 must be broken at contacts 23 24 whenever the direction-reversing current is sent to line; and it is obviously as important that the branch through the contacts 25 26 shall be broken when the alternating pulsator is operating. This is all provided for by the location of the rod 23 and insulated cap 25 relating to springs 26 and shoe 24.

When the paper-shifter commutator or pen-lifter pole-changer is operated there is danger of short circuits unless both of the other branches are simultaneously opened, for otherwise the line might be connected through one of these commutators—say to the positive pole of the battery—and through one of the other branches—say to the negative pole.

Again, it will be seen that the two batteries are connected at the switch 14. Now, if when one battery is connected up with both the lines *a* and *b* through the pole-changer, half of the other battery might be connected up to line *a* through either its alternating pulsator or its insulated cap 25 and contact-springs 26, then a complete circuit might be established from the half of one battery to line *a* and back through one-half of the other battery, and thence across the switch 14. If the two batteries then connected up with the line *a* are reversed respecting each other, the result will be that practically no current would flow along the line *a*. It is for this reason that switch 24′ is introduced, which is opened whenever the pole-changer is operated. If, on the other hand, when the paper-shifter is operated, thereby throwing one of the batteries to line *a*, the other battery happens to be connected up to line *b* through its insulated cap or its pulsator, and the connection happens to be to the other pole of the battery from that connected up through the paper-shifter, the current through the magnet 12 at the receiving-station might be cut down and the paper-shifter fail to operate. To avoid this difficulty I break the connection of the battery which is connected to the pole-changer when operating the paper-shifter. It is obviously immaterial on which side of the battery connected with the pole-changer this break is made, whether in its ground connection or between the battery and the line *b;* but I show the break in a ground connection at switch 14. When the battery connected to the pole-changer is cut off from both of the lines and the other battery is connected up through the paper-shifter to the line *a*, the line *a* is practically a separate line from the line *b* from ground to ground. I believe that I am the first to arrange such a line which includes at the transmitting-station a transmitter for sending currents of both polarities to line that shall control the movement of the pen in the plane of the paper or in a plane parallel thereto and a commutator for cutting out and closing the line around these transmitter appliances and sending a separate set of currents over the writing-wires for operating some other device, as a paper-shifter, at the receiving-station, and including at the receiving-station the magnets which control the movement of the receiving-pen in the plane of the paper or in a plane parallel thereto and a magnet which will control some other device, as, *e. g.*, a paper-shifter.

The current which shifts the paper or lifts or lowers the pen may also reverse the armatures of the direction-controlling magnets 10. An operator may shift the paper or lift the pen while the insulated cap 25 is in contact with one of the springs 26 and holds the spring out of contact with its point 27. Under these conditions if the pen at the transmitter is then moved farther in the same direction, so that the contact between cap 25, spring 26, and point 27 is not re-established, the pens will move in opposite directions; but if the operator when lifting or lowering the pen or shifting the paper will always ease up on the pen the rod 23 will be brought back by the spring until the contact is re-established between cap 25, spring 26, and point 27. The untimely reversal of the magnets 10 by the current through either commutator will then do no harm, since no matter in what direction the pen is moved after the operation of these devices it will first set right the magnet 10 at the receiver-station.

Transmitter and Receiver Switch.

In Fig. 5 is shown the switch which controls the line connections. At each station there is a transmitter and a receiver. The lines *a* and *b* are each connected at each station to a switch consisting of two spring members *s s*, which form a pen-rest. These springs at each station normally contact, as shown at A in the figure, with points in connection to the transmitter similar to the connections of the lines *a* and *b* to the transmitter shown at the top of Fig. 1. When the transmitter-pen is placed in the pen-rest, as shown at station B in Fig. 5, these two springs are forced out of contact with the two points in the connections to the transmitter and are forced into contact with two points in similar connections to the receiver. These two last-named points are in connections to the receiver similar to the connections of the lines *a* and *b* to the receiver shown at the bottom of Fig. 1.

I do not claim the method of commutation at the transmitter herein disclosed, as that is claimed in my pending application, Serial No. 542,621, filed March 21, 1895, for improvements in methods of and apparatus for transmission of autographic signs; nor do I claim the combination of a transmitter-pen and the commutator, nor the particular construction of the pen lifting and lowering commutator herein shown, since that is claimed in my said application.

Without limiting myself to the precise details or devices shown, what I claim, and desire to secure by Letters Patent, is—

1. In a two wire writing telegraph system, the combination of a suitable receiving device at a receiver station, two wires joining the stations, and at the transmitter station means for transmitting over the two lines currents which effect the movements of the receiving pen in extent and intervening currents of both polarities which control the direction of its movements, substantially as described.

2. In a writing telegraph system the combination of a suitable receiving device at a receiver station, two wires joining the stations, and at the transmitter station means for transmitting over the two lines currents which effect the movements of the receiving pen in extent, and intervening currents of both polarities which control the direction of its movement, and means for preventing short circuits in the transmission of these various currents, substantially as described.

3. In a two wire writing telegraph system the combination of a suitable receiving device at a receiver station, two wires joining the stations, and at the transmitter station means for transmitting currents which control the movements of the receiving pen in extent and direction, and means for transmitting a distinct set of currents which effect the lifting and lowering of the receiving pen, and means for transmitting a second distinct set of currents which control the paper shifting at the receiver station, substantially as described.

4. In a two wire writing telegraph system, the combination of a suitable receiving device at the receiving station including means for controlling the movement of the receiver pen in extent and direction, and a supplemental part to effect a fundamental telautographic operation, two wires joining the two stations, and at the transmitter station means for transmitting over the two lines currents which effect the movements of the receiver pen in extent and direction, and means for suspending the transmission of the foregoing currents and transmitting to line currents which effect the operation of the supplemental part of the receiving device, there being currents of both polarities, and means for preventing short circuits in transmission of the various currents, substantially as described.

5. In a two wire writing telegraph system the combination at a receiver station of a suitable device for controlling the movements of the receiver pen both in extent and direction and a polarized pen lifting and lowering device, two wires joining the two stations, and at the transmitter station means for transmitting over the two lines currents which control the movements of the receiving pen in extent and direction, and means for transmitting to line currents of both polarities which effect the lifting and lowering of the receiver pen, and means for preventing short circuits in the transmission of these various currents, substantially as described.

6. In a two wire writing telegraph system the combination of a suitable device at the receiver station for controlling the movements of the receiving pen both in extent and direction, a polarized pen lifting and lowering device, and a paper shifting device, two wires connecting the two stations, and at the transmitter station means for transmitting over the two lines currents which control the movements of the receiving pen in extent and direction, means for transmitting over the two lines currents of both polarities which effect the lifting and lowering of the receiving pen, means for transmitting to line currents which control the shifting of the paper at the receiver station, and means for preventing short circuits in the transmission of these various currents, substantially as described.

7. In a two wire writing telegraph system the combination at the receiver station of a suitable polarized device for controlling the extent of movement of the receiving pen, a suitable polarized device for controlling its direction of movement, and a suitable supplemental device, two wires connecting the two stations, and at the transmitter station means for transmitting over the two lines currents of both polarities which control the extent of movement of the receiving pen, means for transmitting over the two lines currents of both polarities which control the direction of these movements, and means for transmitting to one of said lines currents which control the said supplemental device, and means for preventing short circuits in the transmission of these various currents, substantially as described.

8. In a two wire writing telegraph system the combination at the receiver station of a suitable polarized device for controlling the extent of movement of the receiving pen, a suitable polarized device for controlling its direction of movement, and a suitable polarized device for lifting and lowering it, two wires connecting the stations, and at the transmitter station means for transmitting over the two lines currents of both polarities which control the movements of the receiving pen in extent, means for transmitting over the two lines currents of both polarities which control its direction of movement, and means for transmitting to line currents of both polarities which effect the lifting and lowering of the receiving pen, and means for preventing short circuits in the transmission of the various currents, substantially as described.

9. In a two wire writing telegraph system, the combination of a suitable receiving device at a receiver station, two wires joining the stations, and at the transmitter station means for transmitting over the two lines currents which effect the movements of the receiving pen in extent and stronger currents of both

polarities which control the directions of its movements, substantially as described.

10. In a two wire writing telegraph system the combination of a suitable receiving device at a receiver station, two wires joining the stations, and at the transmitter station means for transmitting over the two lines currents which effect the movements of the receiving pen in extent, and stronger currents of both polarities which control the direction of its movements, and means for preventing short circuits in the transmission of these various currents, substantially as described.

11. In a two wire writing telegraph system the combination of a suitable receiving device at a receiver station, including means for controlling the movement of the receiver pen in extent and direction, and a supplemental part, and two wires joining the two stations, and at the transmitter station means for transmitting over the two lines currents which effect the movements of the receiving pen in extent and direction, and means for transmitting to line stronger currents which effect the operation of the supplemental part of the receiving device, substantially as described.

12. In a two wire writing telegraph system the combination of a suitable receiving device at a receiver station, two wires joining the stations, and at the transmitter station means for transmitting currents which control the movements of the receiving pen, and means for transmitting currents which effect the lifting and lowering of the receiving pen, and means for transmitting currents which control the paper-shifting at the receiver station, the currents which lift and lower the pen and shift the paper being stronger than the other currents, substantially as described.

13. In a two wire writing telegraph system the combination of a suitable receiving device at a receiver station, including means for controlling the movement of the receiver pen in extent and direction, and a supplemental part, and two wires joining the stations, and at the transmitter station means for transmitting over the two lines currents which effect the movements of the receiving-pen in extent and direction, and means for transmitting to line stronger currents which effect the operation of the supplemental part of the receiving device, there being currents of both polarities, and means for preventing short circuits in the transmission of the various currents, substantially as described.

14. In a two wire writing telegraph system the combination at a receiver station of a suitable device for controlling the movements of the receiver pen, and a polarized pen lifting and lowering device, two wires joining the two stations, and at the transmitter station means for transmitting over the two lines currents which control the movements of tho receiving pen, and means for transmitting to line stronger currents of both polarities which effect the lifting and lowering of the receiver pen, and means for preventing short circuits in the transmission of these various currents, substantially as described.

15. In a two wire writing telegraph system the combination of a suitable device at the receiver station for controlling the movements of the receiving pen, a polarized pen lifting and lowering device, and a paper shifting device, two wires connecting the two stations, and at the transmitter station means for transmitting over the two lines currents which control the movements of the receiving pen, means for transmitting over the two lines currents of both polarities which effect the lifting and lowering of the receiving pen, means for transmitting to line currents which control the shifting of the paper at the receiver station, the currents which lift and lower the pen and shift the paper being stronger than the other currents, and means for preventing short circuits in the transmission of these various currents, substantially as described.

16. In a two wire writing telegraph system the combination at the receiver station of a suitable polarized device for controlling the extent of movement of the receiving-pen, a suitable polarized device for controlling its direction of movement, and a suitable supplemental device, two wires connecting the two stations, and at the transmitter station means for transmitting over the two lines currents of both polarities which control the extent of movement of the receiving pen, means for transmitting over the two lines stronger currents of both polarities which control the direction of these movements, and means for transmitting to one of said lines currents stronger than the said direction controlling currents which control the said supplemental device, and means for preventing the short circuits in the transmission of these various currents, substantially as described.

17. In a writing telegraph system the combination at the receiver station of a suitable polarized device for controlling the extent of movement of the receiving pen, a suitable polarized device for controlling its direction of movement, and a suitable polarized device for lifting and lowering it, wires connecting the stations, and at the transmitter station means for transmitting currents of both polarities which control the movements of the receiving pen in extent, means for transmitting currents of both polarities which control its direction of movement, and means for transmitting currents of both polarities which effect the lifting and lowering of the receiving pen, substantially as described.

18. In a writing telegraph system, a combination, in which currents of both polarities are transmitted, consisting of two lines, a branch from each of the lines through a transmitting device, a commutator constructed to throw the two lines into one circuit, and means for breaking the said branches when the said commutator is operated, and at the receiver a loop in which is connected a controlling device, substantially as described.

19. In a writing telegraph system the combination of two lines, a branch from one of the lines through a transmitting device, a pole-changer constructed to throw the two lines into one circuit, and transmit currents of opposite polarity, means for breaking the said branch when the said pole-changer is operated, and at the receiver station a loop in which is connected a pen lifting and lowering device, substantially as described.

20. In a writing telegraph the combination of two lines, a branch from one of the lines through a transmitting device, a pole-changer constructed to throw the two lines into one circuit, and transmit currents of opposite polarity, and means for breaking the said branch when the said pole changer is operated, the said pole changer and branch circuit breaker being operated momentarily by the transmitter pen whenever it is lifted or lowered, and at the other end of the lines a receiver pen, mechanism for causing it to obey the currents from the transmitter, a polarized pen lifting and lowering device which lifts or lowers the pen according to the direction of the current through the pole changer, substantially as described.

21. In a writing telegraph the combination of two lines, a battery having an intermediate ground connection, a branch from one of the lines through a transmitting device to either end of the battery, a commutator for connecting the two ends of the battery to the two lines, means for breaking the said branch when the said commutator is operated, substantially as described.

22. In a writing telegraph the combination of two lines, and, at the transmitter station, a battery having an intermediate ground connection, a branch from one of the lines through a transmitting device, to either end of the battery, a pole changer for connecting the two ends of the battery to the two lines, and means for breaking the said branch when the said pole changer is operated, the pole changer and branch circuit breaker being operated momentarily by the transmitting pen when it is lifted or lowered; and, at the receiver station, a receiving pen, mechanism for causing it to obey the currents from the transmitter and follow the movements of the transmitting pen, and a polarized pen lifting and lowering device which lifts or lowers the receiving pen according to the direction of the current through the pole changer, substantially as described.

23. In a writing telegraph the combination in which currents of both polarities are transmitted consisting of two lines, a branch from each of the lines through a transmitting device, a commutator for connecting both lines together in one circuit, a second commutator for commutating one of the lines independently of the other, and means for breaking both of the above named branches when either of the said commutators is operated, substantially as described.

24. In a writing telegraph the combination of two lines, a branch from each of the lines through a transmitting device, a pen lifting and lowering pole changer connecting both of the lines together in one circuit to transmit both positive and negative currents, a paper shifting commutator for commutating one of the lines independently of the other, and means for breaking both of the above named branches when either the said pole-changer or said commutator is operated, and at the receiver station a pen lifting and lowering device in the loop across the two wires and operated when the pole-changer is operated at the transmitter station, and a paper shifting device in a common ground of the two wires operated when the paper shifting commutator is operated at the transmitter station, substantially as described.

25. In a writing telegraph the combination of a line wire which connects the transmitter and receiver stations, and to which is connected, at the transmitter station, one half of a transmitter, a commutator, for cutting out and closing the line around the said half transmitter, and at the receiving station, one half of a receiver and a magnetic translating device operated only when the line at the transmitter station is closed around the said half transmitter and it is thereby cut out, substantially as described.

26. In a writing telegraph the combination of a line wire which connects the transmitter and receiver stations, and to which is connected, at the transmitter station, one half of a transmitter for sending over the line currents to control the movement of the receiving pen in extent and direction and a commutator for closing the line around and cutting out the said half transmitter to send other currents over the line, and at the receiver station, one half of a receiver and a translating device operated only by the currents sent to line when the line at the transmitter station is closed around the said half transmitter and it is thereby cut out, substantially as described.

27. In a writing telegraph system in which currents of both polarities are transmitted over one line, which line joins a transmitter and a receiver station, the combination of suitable mechanism at the receiver station including a receiver pen, and, at the transmitter station two branches to line, a switch operated by the horizontal movement of the transmitter pen for sending to line one set of currents to control the movements of the receiver pen in extent, means for sending to line a distinct set of currents to accomplish an additional result at the receiver station, each set of currents traversing its own branch, and means for preventing the simultaneous closure of the two branches, substantially as described.

28. In a writing telegraph system in which currents of both polarities are transmitted over one line, which line joins a transmitter and a receiver station, the combination of

suitable mechanism at the receiver station, including a receiver pen, and, at the transmitter station, three branches to line, a switch operated by the horizontal movement of the transmitter pen for sending to line one set of currents to control the movements of the receiver pen in extent, means for sending to said line two other distinct sets of currents to accomplish additional results at the receiver station, each of the three sets of currents traversing its own branch, and means for preventing the simultaneous closure of any two of the branches, substantially as described.

29. In a writing telegraph system, the combination of a line joining a transmitter and a receiver station, at the latter suitable receiving apparatus, including a pen, and at the transmitter station two branches to line, means for sending to line two distinct sets of currents, including currents of both polarities, to accomplish at the receiver station the moving of the pen and the lowering and lifting of the pen respectively, each set of currents traversing its own branch, and means for preventing the simultaneous closing of the two branches, substantially as described.

30. In a writing telegraph the combination of a line joining a transmitter and a receiver station, at the latter suitable receiving apparatus including a pen, and at the transmitter station three branches to line, means for sending to line three distinct sets of currents, each set traversing its own branch, the one set being alternating pulsations and controlling the extent of movement of the receiver pen horizontally, another set being both positive and negative pulsations and controlling the direction of movement of the pen, and the third set being both positive and negative pulsations and controlling the lifting and lowering of the pen, substantially as described.

31. In a writing telegraph system the combination of a line which joins a transmitter and a receiver station, at the latter suitable receiving apparatus including a pen, and, at the transmitter station, three branches to said line, means for sending to said line three distinct sets of currents, each set traversing its own branch, one set being alternating pulsations and controlling the extent of movement of the pen horizontally, another set being both positive and negative pulsations and controlling the direction of movement of the pen, and the third set effecting a supplemental result at the receiver station, and means for preventing the simultaneous closure of any two of the branches, substantially as described.

32. In a writing telegraph the combination of a line, joining a transmitter and a receiver station, at the latter suitable receiving apparatus, including a pen, and, at the transmitter station, two branches to line, means for sending to said line two distinct sets of currents, one set being alternating pulsations, and the other set being both positive and negative currents, to accomplish at the receiver station the moving of the pen and the lifting and lowering of the pen respectively, each set of currents traversing its own branch, and means for preventing the simultaneous closure of the two branches, substantially as described.

33. In a writing telegraph the combination of a line joining a transmitter and a receiver station, at the latter suitable receiving apparatus, including a pen, and, at the transmitter station, three branches to line, means for sending to said line three distinct sets of currents, which include currents of both polarities, each set traversing its own branch, one set controlling the extent of movement of the receiver pen horizontally, another set controlling the direction of movement of the pen, and the third set controlling the lifting and lowering of the pen, and means for preventing the simultaneous closure of any two of the branches in which currents of both polarities are transmitted, substantially as described.

34. In a writing telegraph system in which currents of both polarities are transmitted over one line, which line joins a transmitter and a receiver station, the combination of branches to line at the transmitter station, a switch operated by horizontal movement of the transmitter pen for sending to line one set of currents to control the movements of the receiver pen in extent, means also operated by the transmitter pen for sending to line one or more additional distinct sets of currents, each of all of the said sets of currents traversing its own branch, and means operated by the transmitter pen for preventing simultaneous closure of any two of the branches in which currents of both polarities are transmitted, and at the receiver station suitable receiving mechanism, including a pen, and distinct means operated each by one of the said sets of currents, and each effecting a distinct telautographic operation, including the control of the movements of the receiver pen in extent, substantially as described.

35. In a writing telegraph the combination of a line joining a transmitter and a receiver station, at the latter suitable receiving mechanism including a pen, and at the transmitter station two branches to line, a transmitter which includes two circuit closers, one in each branch, operated manually with the pen for sending to line two distinct sets of currents, which include currents of both polarities, each set traversing its own branch, one set to control the movement of the receiver pen in extent and the other to control the direction of its movement, and mechanical connection between the two circuit closers whereby the direction controlling branch is closed and then opened before the other branch is closed, substantially as described.

36. In a writing telegraph the combination of a line joining a transmitter and a receiver station, at the latter suitable receiving mechanism, including pen, and, at the transmitter

station, three branches to line, a transmitter for sending to line two distinct sets of currents, which include currents of both polarities, one set controlling the extent of movement of the receiver pen horizontally, the other set controlling the direction of movement of the receiver pen, and a pole-changer for sending to line a third set of currents which control the lifting and lowering of the receiving pen, each of the three sets traversing its own branch, and means operated by the transmitting pen for preventing the simultaneous closure of any two of the branches, substantially as described.

37. In a writing telegraph system a transmitter, a branch to line which includes a pulsator and a switch, a second and distinct branch to line which includes a second and distinct switch for sending both positive and negative currents, and means for preventing the simultaneous closure of the two switches, substantially as described.

38. In a writing telegraph system a transmitter, a branch to line which includes an alternating pulsator and a switch, a second and distinct branch to line which also includes a second and distinct switch, means for sending a distinct set of currents over the second branch, and means for preventing the simultaneous closure of the two switches, substantially as described.

39. In a writing telegraph system a transmitter, a branch to line which includes an alternating pulsator and a switch, a second and distinct branch to line which includes a second and distinct switch for sending both positive and negative currents, and means for preventing the simultaneous closure of the two switches, substantially as described.

40. In a writing telegraph transmitter constructed to transmit to line currents of both polarities, the combination of two switches each in a separate branch to line, one switch being in a branch with a pulsator, and connected by the pen to the switch in the other branch, the action between the switches being such that the latter switch closes and again breaks its branch before the former switch is closed, substantially as described.

41. In a writing telegraph transmitter constructed to send to line currents of both polarities the combination of a transmitter pen, a current pulsator operated thereby through mechanism to which is also attached a switch arm having two contact points insulated from each other, two sets of contacts cooperating with these two points on the switch arm, one member of each of these sets of contact points lying on either side of the switch arm, two branches to the one line, one through the pulsator the switch arm and one set of contacts, and the other through the switch arm and the other set of contacts, the two sets of contacts being so constructed and adjusted relatively to each other that the second branch is closed and then broken before the first branch is closed, each time that the switch arm is moved in either direction from its natural position, substantially as described.

42. In a writing telegraph transmitter the combination of a transmitting pen, connections to line through a switch that is closed by movement of the pen without respect to the direction of motion of the pen, or its range of motion beyond certain limits, means for opening this switch immediately on reversal of motion of the pen, means for sending alternating pulsations to line through this switch, a connection to line in parallel with and beyond this switch, and a second switch arranged to send currents of both polarities to line, the direction of the currents being dependent on direction of motion of the pen, and means whereby the said second switch is closed and then opened before the said first switch is closed, substantially as described.

43. A two wire writing telegraph transmitter comprising the combination of a transmitting pen, a pulsator for sending alternating currents to each line, the number of pulsations being dependent on the extent of movement of the pen, switches for sending positive or negative currents to said lines upon each reversal of direction of movement of the pen, the direction of the current being dependent on the direction of the pen movement, substantially as described.

44. In a two wire writing telegraph the combination of a transmitting pen, a branch which includes a pulsator for sending alternating currents to each line, the number of pulsations being dependent on the extent of movement of the pen, a second branch to each line which includes a switch for sending a positive or negative current to line upon each reversal of direction of movement of the pen, the direction of the current being dependent on the direction of the pen movement, and means whereby the said switch is first closed and then opened before the branch through the pulsator is closed, substantially as described.

45. In a writing telegraph system, at the transmitter the combination of a transmitting pen, connections to a line through a switch that is closed by movement of the pen without respect to the direction of motion of the pen, or its range of motion beyond certain limits, means for opening this switch immediately on reversal of motion of the pen, means for sending alternating pulsations to the said line through this switch, a connection to said line in parallel with and beyond this switch, and a second switch arranged to send currents of both polarities to line, the polarity of the currents being dependent on direction of motion of the pen, and means whereby the said second switch is closed and then opened before the said first switch is closed, and at the receiver station a receiving pen, means controlled by the aforesaid alternating pulsations, for effecting the movement of the receiver pen, and means controlled by the aforesaid currents of both polarities for effect-

ing changes of direction of movement of the receiver pen, substantially as described.

46. In a writing telegraph transmitter the combination of a transmitting pen, a pulsator for sending alternating currents to a line, the number of pulsations being dependent on the extent of movement of the pen, a switch for sending a positive or negative current to said line upon each reversal of direction of movement of the pen, the polarity of the current being dependent on the direction of the pen movement, and at the receiver station a receiving pen, means controlled by the said alternating currents, for effecting its movement, and means controlled by the aforesaid positive and negative currents, for effecting changes of direction of its movement, substantially as described.

47. In a writing telegraph the combination of a transmitting pen, a branch which includes a pulsator for sending alternating currents to a line, the number of pulsations being dependent on the extent of movement of the pen, a second branch which includes a switch for sending a positive or negative current to said line upon each reversal of direction of movement of the pen, the polarity of the current being dependent on the direction of the pen movement, and means whereby the said switch is first closed and then opened before the branch through the pulsator is closed, and at the receiver station a receiving pen, means controlled by the said alternating currents, for effecting its movement, and means controlled by the said positive and negative currents for effecting changes of direction of its movement, substantially as described.

48. In a writing telegraph transmitter two points connected with opposite ends of a battery and otherwise insulated from each other, a contact finger which alternately contacts with them, two contact members, cooperating mechanically, one electrically connected with the said finger and the other insulated therefrom, two contacting strips insulated except for two points connecting them each with one end of the battery, the said strips being in the path of the insulated members, and connecting it with one or the other of said points last named on a partial movement of the said members, and being disconnected from the said points by further movement of the said insulated member, a contact shoe in position to contact with the non-insulated member upon such further movement only, connections from the insulated member and the said contact shoe to line, substantially as described.

49. In a writing telegraph transmitter two points connected with opposite ends of a battery and otherwise insulated from each other, a contact finger which alternately contacts with them, two cooperating contact members, one electrically connected with the said finger and the other insulated both from the said other member and the said finger, each of said contact members contacting with one of two pairs of points, there being a point of each pair on each side of the said members, the two points of one of the pairs being connected and the two points of the other pair being insulated from each other, the said insulated points being connected respectively to opposite ends of the battery and being in the path of the said insulated member, which on movement in either direction is first connected through one of the points to one end of the battery and then on further movement is disconnected, the said further movement bringing the uninsulated contact member into contact with one of the uninsulated pair of contact points, and connections from the said insulated member and the said uninsulated pair of contact points to line through different branches, substantially as described.

50. In writing telegraphs, the combination with the transmitter and receiver and two main line wires connecting the same, of a commutator at the transmitter adapted to transform the said main line wires into a single metallic circuit, changing the polarity at each transformation, substantially as described.

51. In writing telegraphs, the combination with the transmitter and receiver, two main line wires and the pen lifting and lowering system at the receiver, of a commutator at the transmitter adapted to momentarily transform the two line wires into a metallic circuit, changing the polarity at each transformation and instantly restoring circuits and batteries to their normal condition, substantially as described.

52. In writing telegraphs, the combination with the transmitter and receiver and two main line wires connecting the same, of means located at the transmitter and cooperating therewith for commutating the said main line wires and batteries, when the transmitting pen is raised or lowered, whereby additional main lines for giving the perpendicular movements to the receiving pen are dispensed with, substantially as described.

53. In writing telegraphs, the combination with the transmitter and receiver and two main line wires connecting the same, of means at the transmitter which cooperates therewith to commutate said main lines, when the transmitting pen is raised or lowered, changing the polarity at each of said movements, and a condenser at the receiver cooperating with the commutated main lines, substantially as described.

54. In writing telegraphs, the combination with the receiver and transmitter and two main line wires connecting the same, of a condenser and polarized relay bridged across the incoming line wires at the receiver and controlling the pen lifting mechanism, and a commutator at the transmitter which cooperates therewith to transform the lines and batteries to send the impulses which produce the perpendicular movements of the receiving pen, substantially as described.

55. In writing telegraphs, the combination with the transmitter and receiver and two main line wires connecting the same, of a commutator at the transmitter for the main lines, a series of batteries, and a polarized relay and condenser at the receiver, substantially as described.

56. In writing telegraphs, the combination with the transmitter and receiver and two line wires connecting the same and grounded at both ends, of mechanism for breaking the ground at the transmitter and commutating the lines and batteries when the stylus of the transmitter is lifted from or lowered to the paper, substantially as described.

57. In a writing telegraph the combination with a series of batteries, a transmitter, a receiver, and two line wires connecting the same and grounded at both ends, of a commutator at the transmitter adapted to break the ground at the transmitter and commutate the lines and batteries when the stylus of the transmitter is lifted from or lowered to the paper, substantially as described.

Signed by me in New York city this 8th day of January, 1894.

JAMES HART ROBERTSON.

In presence of—

THOMAS EWING, Jr.,

SAMUEL W. BALCH.