G. S. TIFFANY.

TELAUTOGRAPH.

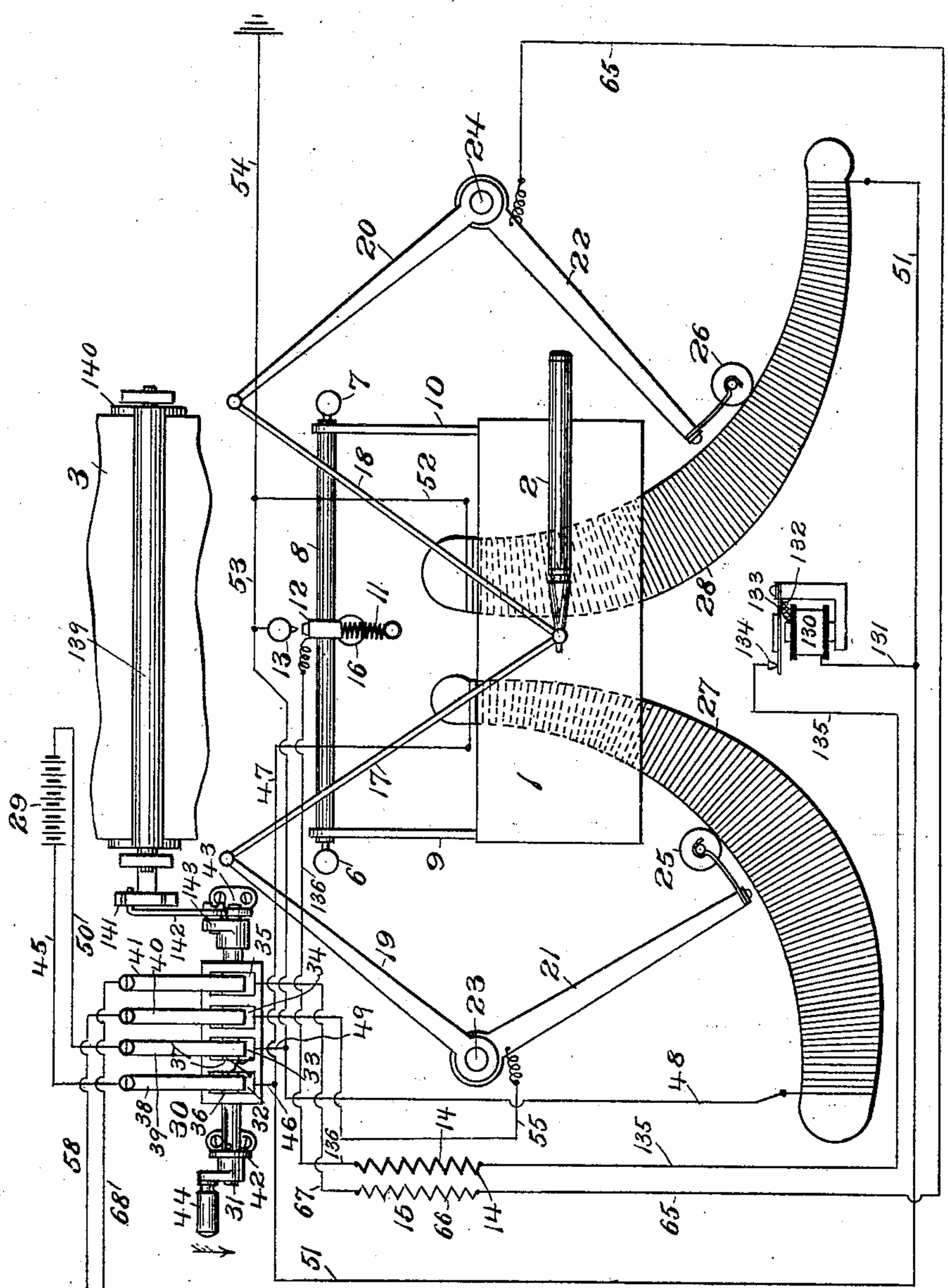
APPLICATION FILED JULY 6, 1906.

923,385.

Patented June 1, 1909.

5 SHEETS—SHEET 1.

Fig. 1.



Witnesses
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5 SHEETS—SHEET 2.

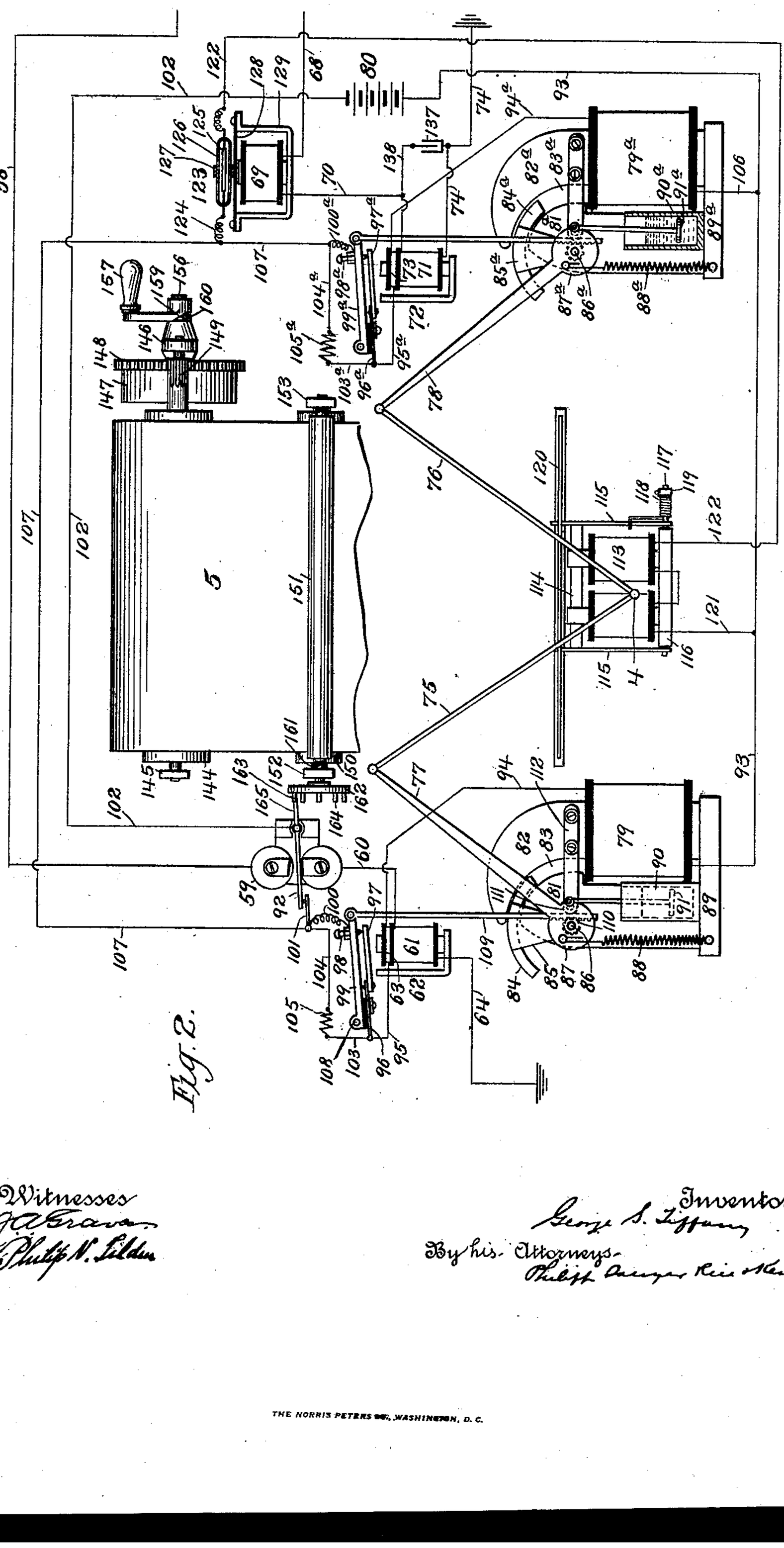

Fig. 2.

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5 SHEETS—SHEET 3.

Fig. 3

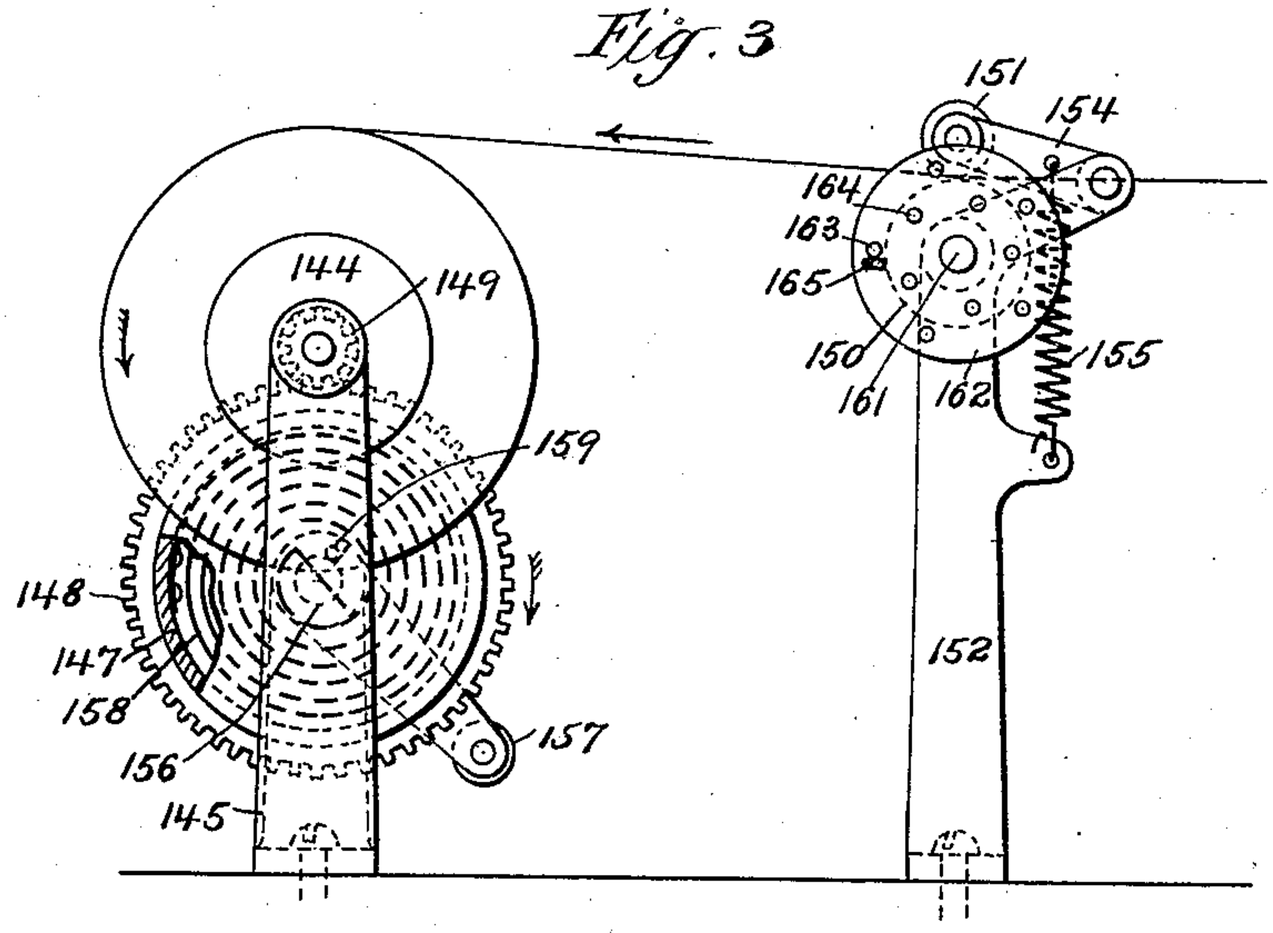


Fig. 5.

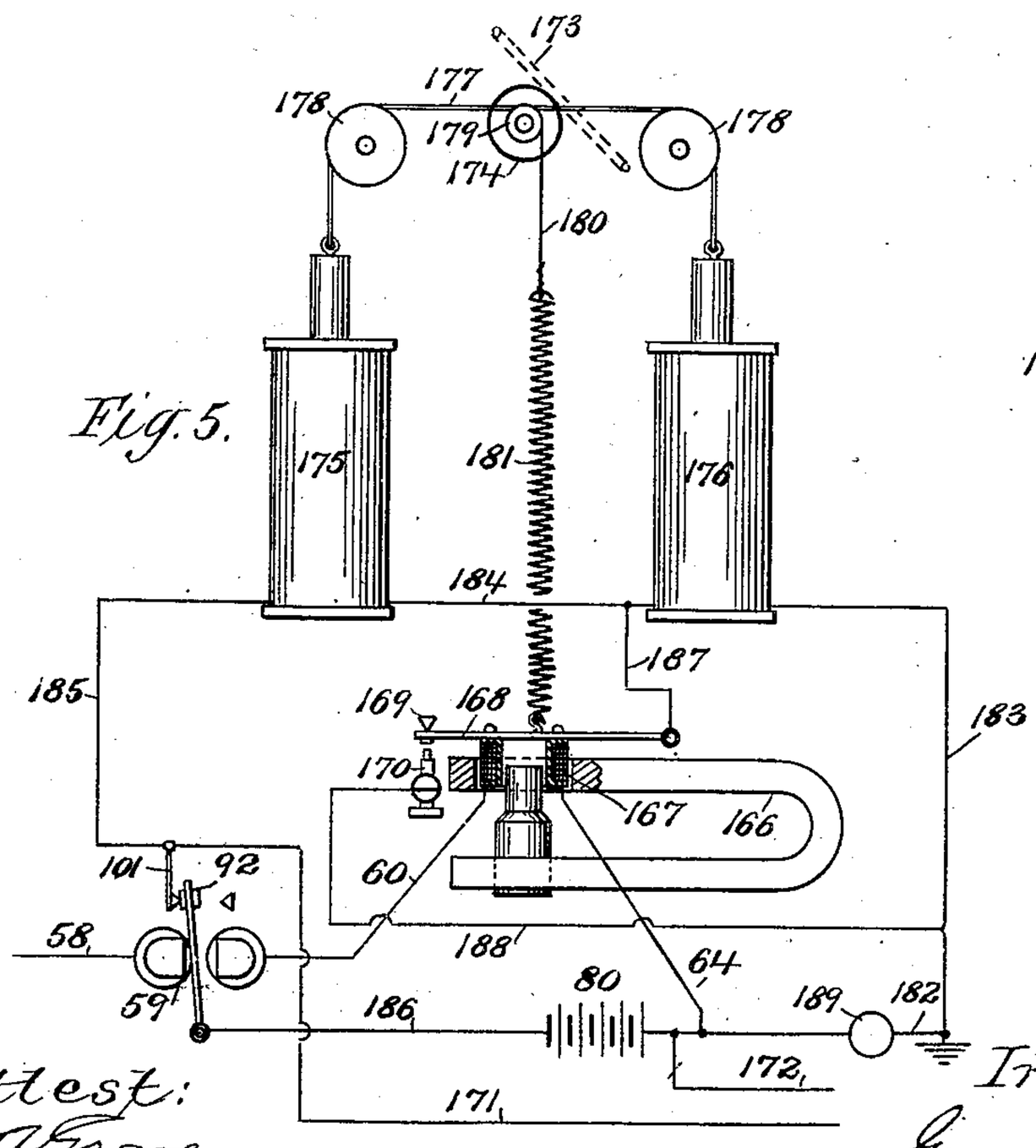
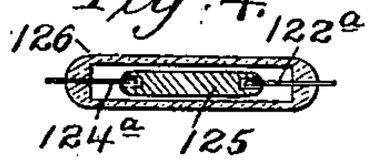


Fig. 4.



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5 SHEETS—SHEET 4.

Fig. 7.

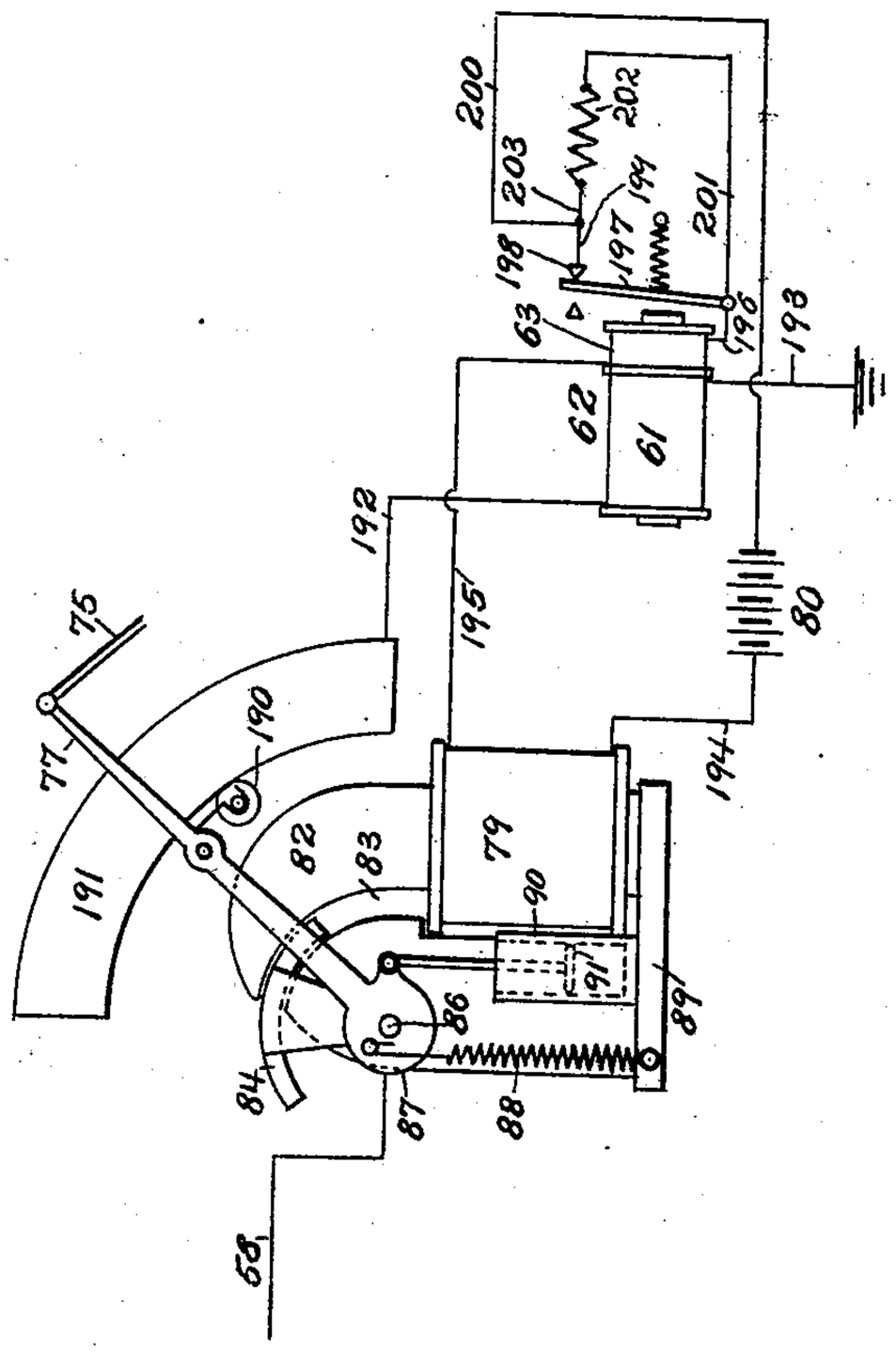
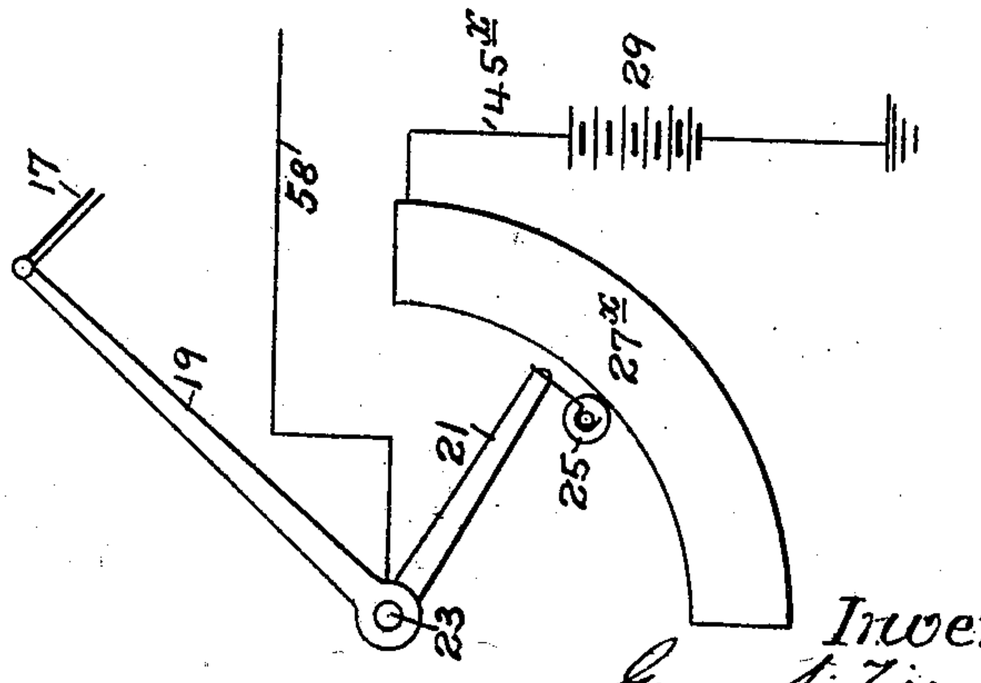


Fig. 6.



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5 SHEETS—SHEET 5.

Fig. 9.

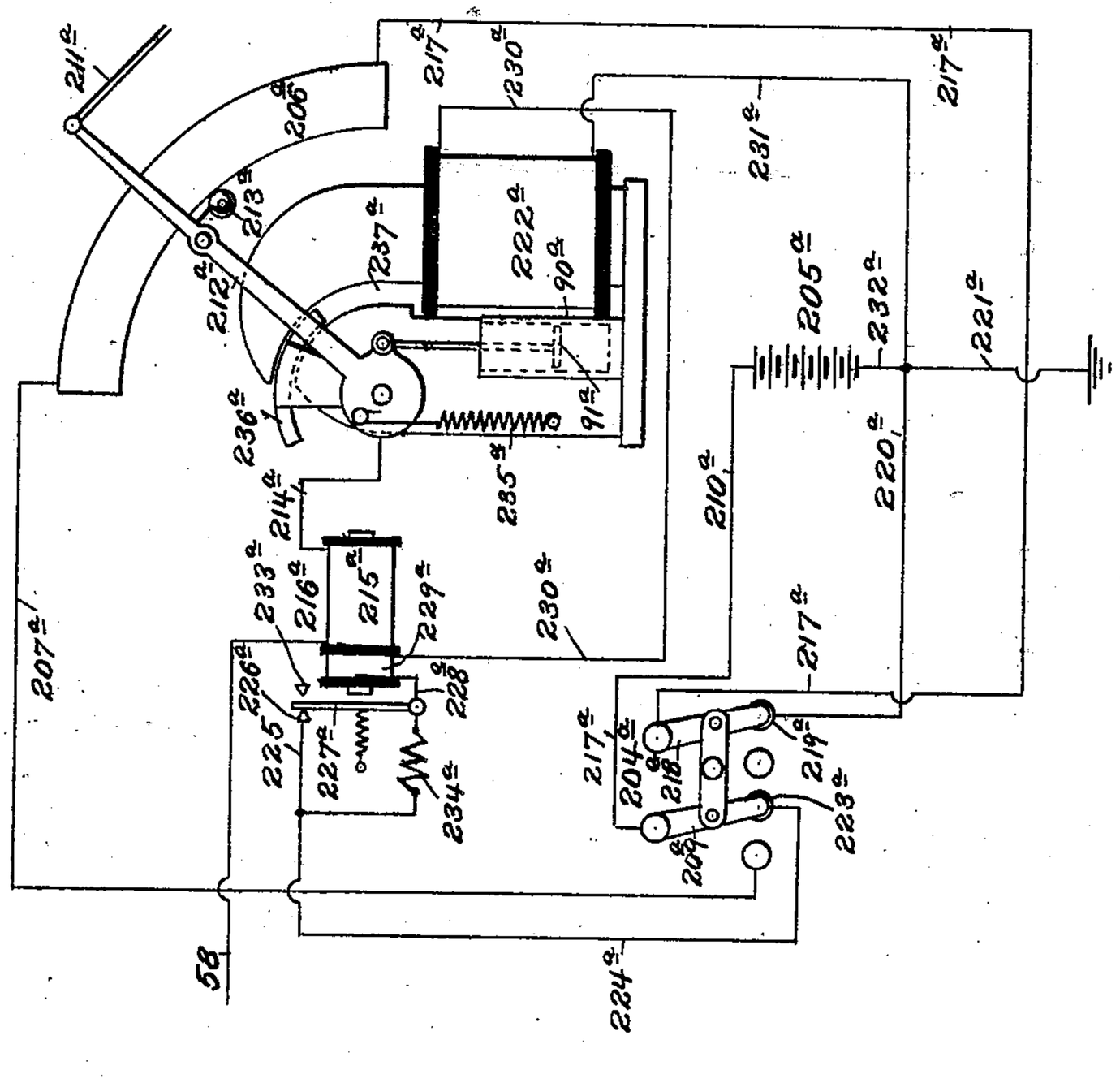
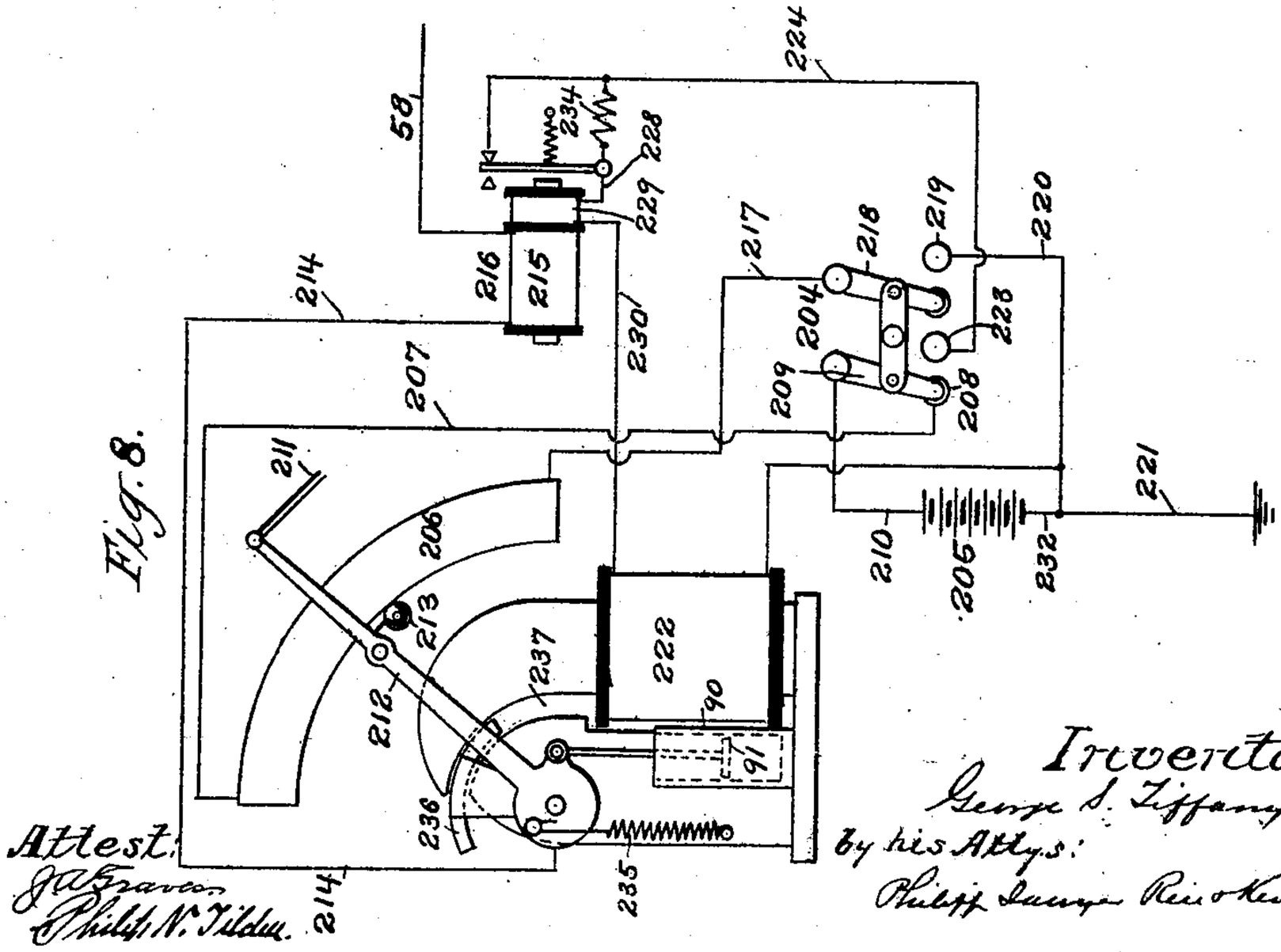


Fig. 8.



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UNITED STATES PATENT OFFICE.

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TELAUTOGRAPH.

No. 923,385. Specification of Letters Patent. Patented June 1, 1909.

Application filed July 6, 1906. Serial No. 324,960.

To all whom it may concern:

Be it known that I, GEORGE S. TIFFANY, a citizen of the United States, residing at Summit, county of Union, and State of New Jersey, have invented certain new and useful Improvements in Telautographs, fully described and represented in the following specification and the accompanying drawings, forming a part of the same.

This invention relates to improvements in telautographic systems of the kind shown and described in Letters Patent of the United States granted to me February 26, 1901, Nos. 668,889, 668,890 and 668,895, that is to say, telautographic systems in which the movements of the receiving pen in unison with the transmitting tracer are effected by variations in the strength of the main line currents sent, such variations in current strength being in turn effected by and corresponding to the extent and direction of movement of the transmitting tracer. In telautographic apparatus of this kind, as heretofore generally used commercially, the magnetic devices for so moving the receiving pen have been actuated directly from the main line currents, and in order that such devices, and therefore the receiving pen, might be positively controlled from the transmitting station, and their frictional resistance to movement readily overcome, it has been found necessary, in practice, to use a very large amount of energy on the main line circuits,—such an amount, for example, as would exclude the use of batteries as the source of electric energy, particularly when the main line circuits are of high resistance. This has presented a very serious difficulty or obstacle to the general introduction of telautographic apparatus, which it is the main object of the present invention to overcome. To that end there is provided by the present invention telautographic apparatus in which the magnetic pen-moving parts of the receiver are not so actuated directly by the currents on the main line circuits, as heretofore, but from a local circuit or circuits, suitably controlled by local devices, such as relays, which are in turn controlled by the main line currents. The result of this construction is that the amount of energy required in the main line circuits is so materially reduced that batteries, and even dry batteries, may be used therein as the source of electric energy, the only work required of them being the actuation of these local controlling devices or relays, which requires comparatively little energy, while the work of moving the receiving pen and the magnetic devices with which it is connected is effected by the local circuit or circuits controlled by the relays, which also require but little energy in order to perform the work required of them.

As a full understanding of the improvements of the present invention can best be had from a detailed description of an organization embodying the same, such description will now be given in connection with the accompanying drawings, in which—

Figures 1 and 2 are diagrammatic views of so much of a transmitting instrument and a receiving instrument, respectively, as is necessary for an understanding of the improvements constituting the present invention; the transmitting tracer and receiving pen of the two instruments being shown out of their unison positions and in about their mid-position in their respective fields of writing. Fig. 3 is an end view, partly in section and looking toward the right of Fig. 2, illustrating particularly the paper shifting mechanism at the receiving instrument. Fig. 4 is a detail, on an enlarged scale, of part of the electrical devices at the receiving instrument for controlling the pen lifting magnet. Fig. 5 is a diagrammatic view of a portion of a receiving instrument, illustrating a modification in the magnetic devices at the receiving instrument for controlling the lateral movements of the receiving pen. Figs. 6 and 7 are diagrammatic views of a transmitter and receiver, illustrating the modifications in said pen-controlling magnetic devices; and Figs. 8 and 9 are diagrammatic views of a transmitter and receiver illustrating further modifications in said pen-controlling magnetic devices.

Before entering upon a detailed description of the mechanism shown in the principal figures of the drawings, it may be well to state that, although each station of a telautographic system is ordinarily equipped with a transmitting instrument and a receiving instrument, so that each station may receive as well as transmit messages, only two instru-

ments, namely, a transmitting instrument (Fig. 1), and a receiving instrument (Fig. 2), are shown in the drawings for the two stations which Figs. 1 and 2 are intended to represent, such showing being deemed sufficient for the purposes of the present application.

Referring particularly to Figs. 1 and 2, 1 represents the writing platen of the transmitting instrument, 2 the transmitting tracer (usually a pencil), and 3 the record strip on which it traces the messages transmitted (Fig. 1); while 4 represents the receiving pen and 5 the record strip on which it records the messages received (Fig. 2). So far as the transmitter parts referred to are concerned, they are, generally considered, of familiar construction and arrangement so that the following brief description thereof will suffice in the present case. The writing platen is pivotally mounted, so as to have a slight amount of swinging movement vertically (for a purpose hereinafter explained), in suitable supports 6, 7 between which is pivoted a bar 8 to which are rigidly secured arms 9, 10 extending rearwardly from platen 1. Platen 1 is held yieldingly in its raised position by means of a retractile spring 11 connected with bar 8 and the frame of the instrument, so that when the transmitting tracer is pressed downwardly upon the platen, by the operator in writing, said platen will be slightly depressed. The bar 8 has attached to it a contact plate 12, which, when the platen 1 is thus depressed by the pressure of the tracer 2, and the bar 8 therefore rocked on its supports 6, 7, will engage a stationary contact 13, which limits the rocking movement of bar 8 and downward movement of platen 1, and thus close the circuit through the primary winding 14 of an induction coil 15 for a purpose which will be hereinafter described. It will be understood, of course, that, except when the platen 1 is so depressed by the tracer 2, contact 12 is held out of engagement with contact 13 and against a back stop 16, the circuit just referred to being therefore open.

The transmitting tracer 2 is pivotally mounted, so as to be free to be moved laterally by the operator in all the directions required in writing, in the converging ends (or one of them) of a pair of pen arms 17, 18 which are in turn pivoted to the outer ends of a pair of pen arm levers 19, 20, respectively, the inner ends of which are fixed to a pair of levers 21, 22, respectively. At their junction, levers 19, 21 are mounted, so as to swing or oscillate freely in a horizontal direction, on a post 23 rising from the base of the instrument, while the levers 20, 22 are similarly mounted on a post 24. The levers 21, 22, carry, at their outer or free ends, spring mounted metal contact rollers 25, 26, respectively, bearing against horn-shaped rheostats 27, 28, respectively, through which, as will presently appear, currents, varying in strength in accordance with the position of these contact rollers between the ends of these rheostats, are shunted from an independent circuit, from a battery 29, into the main line circuits leading to the receiving instrument. The opening and closing of the independent circuit just referred to from battery 29, and the opening and closing of the two main lines leading to the receiving instrument, is controlled by a master switch 30, a detailed description of which is of no moment so far as the present invention is concerned. Briefly described, however, this master switch consists of a block of suitable insulating material secured to a shaft 31 and provided with a series of contact plates 32, 33, 34, 35, 36, 37, coacting with a series of contact springs 38, 39, 40, 41. The shaft 31 is journaled, at its ends, in suitable supports 42, 43 rising from the base of the instrument, and is provided at its outer end with a handle or crank 44 by which it and the master switch 30 may be rocked back and forth (or in one of these directions, in which case a spring will be provided for moving them in the other) for the purpose of closing or opening the independent circuit from battery 29 and also the main line circuits from the transmitting instrument to the receiving instrument when it is desired to transmit messages or to shift the paper at the receiving instrument for the reception of such messages, as will hereinafter appear.

When the master switch is in the position in which it is shown in Fig. 1, *i. e.*, transmitting position, the independent circuit just referred to from battery 29 is closed and consists of wire 45 from the positive pole of said battery, contact spring 38, contact plate 32 on the master switch, and wire 46, where the circuit is divided,—one part of the circuit, as thus divided, consisting of wire 47, left hand rheostat 27, wire 48, wire 49, contact plate 33 on master switch 30, contact spring 39, and wire 50 to the negative pole of battery 29,—while the other part of the circuit, as thus divided, consists of wire 51, right hand rheostat 28, wire 52, wire 53, wire 49, contact plate 33, contact spring 39, and wire 50 to the negative pole of battery 29. It will be observed that the negative pole of battery 29 is connected with ground by wires 53, 54.

When the independent circuit from battery 29 is closed by the engagement of contact plates 32, 33 with contact springs 38, 39, respectively, and the contact rollers 25, 26 are moved back and forth between the ends of their rheostats 27, 28, respectively, as the transmitting tracer 2 is moved laterally to or over the writing platen 1 in transmitting a message, currents varying in strength in accordance with the direction and extent of movement of the tracer and contact rollers 25, 26, will be shunted, through rheostats 27, 28, into the main line circuits leading to the

receiving instrument. As these contact rollers 25, 26 approach the smaller ends of their rheostats 27, 28, respectively, the currents thus shunted into the main line circuits will increase in strength, while as the contact rollers approach the opposite or larger ends of their rheostats 27, 28, such currents will decrease in strength.

There are two main line circuits between the transmitting and receiving instruments—one (the left line circuit) to which current is supplied through rheostat 27, and the other (the right line circuit) to which current is supplied through rheostat 28. With the master switch 30 in the position in which it is shown in Fig. 1, the left line circuit consists (Fig. 1) of contact roller 25, lever 21, wire 55, contact plate 34, on master switch 30, contact spring 40, wire 58, and (Fig. 2) wire 58, the windings of a polarized relay 59 (the function of which will be hereinafter explained), wire 60, leading therefrom, one winding 61 of a relay 62 (which has a second winding 63 and the functions of which will also be hereinafter explained), wire 64 to ground, and (Fig. 1) from ground, by wires 54, 53, contact plate 33, contact spring 39, and wire 50, to the negative pole of battery 29. In this position of the master switch, also, the right line circuit consists (Fig. 1) of contact roller 26, lever 22, wire 65, secondary winding 66 of induction coil 15, wire 57, contact plate 35, on master switch 30, contact spring 41, wire 68, and (Fig. 2) wire 68, the winding of a relay 69 (the functions of which will be hereinafter explained), wire 70, one winding 71 of a relay 72 (corresponding to relay 62 and, like the latter, having a second winding 73), and wire 74 to ground, and (Fig. 1) from ground, by wires 54, 53, contact plate 33, contact spring 39, and wire 50, to the negative pole of a battery 29. The two windings 61, 63 of relay 62, are in the same direction, but winding 61 has many turns while winding 63 has comparatively few turns; and this is also true of windings 71, 73 of relay 72.

From the foregoing it will be understood that, as the transmitting tracer 2 is moved laterally from its unison position to a position in line with the field of writing, over writing platen 1, or is moved laterally over such field in tracing the message to be transmitted, thus moving the contact rollers 25, 26, back and forth between the ends of the rheostats 27, 28, respectively, currents, varying in strength in accordance with the direction and extent of these movements, will be shunted from battery 29 through rheostats 27, 28 into the left and right main line circuits just described, the currents thus shunted into the left line circuit passing, by wires 58, 60, 64, through the relays 59, 62 at the left hand side of the receiving instrument, while those shunted into the right main line circuit pass, by wires 68, 70, 74 through the relays 69, 72 at the right hand side of the receiving instrument.

Referring now particularly to Fig. 2, it will be observed that, as in prior telautographic apparatus, the receiving pen 4 is mounted in the converging ends (or one of them) of a pair of pen arms 75, 76, the other ends of which latter are pivotally mounted in the ends of a pair of pen arm levers 77, 78, respectively; these arms and levers, with the magnetic devices and connections which will now be described, serving to control the lateral movements of the receiving pen 4 so as to cause it to reproduce the lateral movements of the transmitting tracer. As these magnetic devices and connections are alike for both sides of the receiving instrument, a description of one set will be sufficient,—the same reference numerals being applied to corresponding parts in the two sets, except, however, that in the set not specifically referred to, in the following description, such reference numerals will, for convenience in describing the operation of the apparatus, be followed by the reference letter "*a*". Selecting, therefore, the left hand side of the receiving instrument, it will be observed that it is provided with an electro-magnet 79 energized by a local circuit from a battery 80, this circuit being controlled by relay 62, which it also aids in energizing, all as hereinafter fully explained. Magnet 79 has upwardly projecting pole pieces 81, 82, the upper portions of which are suitably spaced apart to provide between them an arc-shaped gap 83 in which is adapted to move an arc-shaped armature 84 fixed to or forming part of an arm or carrier 85 secured to a shaft 86 suitably journaled in pole piece 81. The shaft 86 has also fixed to it the lower end of pen arm lever 77, which is preferably provided with a hub or enlargement 87 with which is connected one end of a retractile spring 88, the other end of which is connected with the heel iron 89 of magnet 79. The function of this spring 88 is to act in opposition to the pull of magnet 79 on its armature 84, and, as the pull of said magnet relaxes, to withdraw armature 84 from gap 83 and rock it, the shaft 86 and lever 77 upwardly and away from magnet 79, to normal position. In order that the tension of the spring 88 may be maintained substantially constant throughout the movements of the armature 84, so as to avoid abruptness or "jerkiness" in the movements of the receiving pen 4, the upper end of said spring is so connected with the hub 87 that as the armature 84 moves into the gap 83 said point of connection will, in moving upward, gradually approach the vertical plane of the axis of shaft 86, and vice versa. A dash pot 90 is also provided for retarding the movements of the armature 84 and lever 77 as magnet 79 is energized and

deënergized, this dash-pot being provided with a piston 91, the rod of which is connected with the hub 87 of lever 77 at a point diametrically opposite, or substantially so, to spring 88.

It will, of course, be understood that as magnet 79 is energized, its armature 84 will be drawn into the gap 83 between the magnet pole-pieces, and that, as the armature is so moved, the shaft 86 will be rocked, and, through lever 77 and arm 75 move the receiving pen 4 to the right, and also that as magnet 79 is deënergized, the receiving pen will be moved in the opposite direction by retractile spring 88; this being also equally true of right hand magnet 79[a] and its retractile spring 88[a]. It will also be understood that the extent of such movements of the receiving pen 4 will depend upon the extent to which the magnet is energized or deënergized, and furthermore, that the two magnets 79, 79[a] will coöperate together in producing lateral movements of the receiving pen in all the directions and to all the extents, to and from and within the limit of the field of writing, necessary to reproduce the movements of the tracer of the transmitting instrument.

The local circuit just referred to for energizing left hand magnet 79 consists (in the position in which the armature 92 of polarized relay 59 is shown) of wire 93, from the positive pole of local battery 80, winding of magnet 79, wire 94, the winding 63 of relay 62, wire 95, spring 96, armature 97 of relay 62, contact 98 adjustably mounted in armature carrier 99 (armature 97 being connected with said carrier by the spring 96 which is suitably insulated from the carrier), wire 100, stationary contact 101, armature 92 of relay 59, and wire 102 to the negative pole of battery 80; a shunt 103, 104, containing a resistance 105, being provided in this circuit around armature 97 and contact 98 for a purpose hereinafter explained. The circuit for energizing right hand magnet 79[a] consists of wire 93, wire 106, winding of magnet 79[a], wire 94[a], winding 73 of relay 72, wire 95[a], spring 96[a], armature 97[a], adjustable contact 98[a] on armature carrier 99[a], wire 100[a], wire 107, stationary contact 101, armature 92 and wire 102 to the negative pole of battery 80; this circuit being also provided with a shunt around armature 97[a] and contact 98[a], consisting of wires 103[a], 104[a] containing a resistance 105[a]. The position in which armature 92 of polarized relay 59 is shown in Fig. 2 is the position assumed by it while a positive current is on the left main line circuit from battery 29 (Fig. 1) of the transmitting station and as this is the polarity of the current on line during a transmitting operation it follows that during such operation the local circuits, just described, from battery 80, will be closed, and magnets 79, 79[a] thus energized, the strength of the currents through said magnets being, however, controlled by relays 62, 72 as hereinafter explained. With armature 92 of relay 59 in this position, also, relays 62, 72 will be energized by the currents traversing the main line circuits 58, 68, respectively, the extent to which they are thus energized varying in accordance with the strength of these main line currents, which in turn is determined by the position of the contact rollers 25, 26, lengthwise of their rheostats 27, 28, respectively, as before stated. It will be observed, as before indicated, that the local circuits at the receiver, from magnets 79, 79[a] also assist in energizing relays 62, 72 by passing through the windings 63, 73, of said relays, which windings are as before stated, in the same direction as the windings 61, 71, respectively, of said relays.

It is necessary, of course, that the extent of movement of armatures 84 and 84[a] of magnets 79, 79[a], should correspond to the variations in the main line currents in order that the receiving pen 4 may be made to reproduce, in extent and direction, the movements laterally of the transmitting tracer, and this result is attained in the present case by connections between the magnets 79, 79[a] and their corresponding relays 62, 72 which will now be described.

Continuing the description with reference particularly to the left hand side of the receiving instrument, it will be observed that the local circuit from battery 80, for magnet 79, is controlled, not only by armature 92, of relay 59, and contact stop 101, but by spring-mounted armature 97 and contact stop 98 on armature carrier 99, which are interposed, in said local circuit, between said armature 92 and battery 80. This armature carrier is pivoted at 108 and is movable bodily to and from relay 62, carrying with it the armature 97, while the latter is also, because of its connection therewith through spring 96, movable relatively to the carrier, and, therefore, to and from contact stop 98; and it is, by reason of these bodily and relative movements of the armature carrier 99 and the armature 97, that the receiving pen 4 is caused to reproduce the movements of the transmitting tracer, as will presently be made clear. The movements of the armature 97 relatively to its carrier 99 and contact stop 98 are effected, in one direction, by armature spring 96, and, in the other, by the energization of relay 62; while the bodily movements of the armature carrier 99, and with it the armature 97, are effected, in one direction, by the energization of magnet 79 and, in the other, by retractile spring 88 as the magnet 79 is deënergized. For the purpose of effecting these movements of the

armature carrier 99, said carrier has pivotally connected with it the upper end of a rack bar 109, the lower end of which meshes with a pinion 110 fast on shaft 86, (said rack bar being maintained in engagement with said pinion by a roller 111 mounted on an arm 112 secured to pole piece 82) so that when armature 84 is drawn into gap 83, as magnet 79 is energized, and shaft 86 thus rocked upwardly, rack bar 109 and armature carrier 99 will be pulled downwardly and armature 97 thus brought closer to the core of relay 62; the reluctance of the magnetic circuit thereof being thus decreased, while, as magnet 79 is deënergized, spring 88 will, through hub 87, rock the shaft 86 in the opposite direction and move rack bar 109 and armature carrier 99 upwardly, the reluctance of the magnetic circuit of relay 62 being thus increased. The extent to which armature carrier 99 is thus moved, in either direction, will depend upon the stength of the current passing through magnet 79, from time to time, and this is controlled by the strength of the currents sent over the main lines from time to time in the operation of the transmitting instrument, as will now be made clear.

It will be understood that with master switch 30 in the position shown in Fig. 1, with its contact plates 32, 33, 34, 35 in engagement with contact springs 38, 39, 40, 41, respectively, positive currents will traverse the two main lines 58, 68, leading to the receiving instrument, as before explained; that the current traversing the left line 58 will bias the armature 92 of polarized relay 59 against contact stop 101 and thus close the local circuits referred to from positive pole of battery 80 through both of the magnets 79, 79[a]; and that the relays 62, 72, will be energized by these main line currents, more or less according to the strength of the currents, and also, to some extent, by the currents passing through their windings 63, 73, respectively, from local battery 80.

The operation of this part of the apparatus is as follows:—In the position in which they are shown in Figs. 1 and 2, respectively, the transmitting tracer and receiving pen have been moved from unison to about the middle of their respective writing fields. In this position of the tracer, the currents traversing both main lines are of about equal strength, and, as the contact rollers 25, 26 are about midway of the length of their respective rheostats 27, 28, that traversing each line is about the mean strength of current traversing that line in a transmitting operation. Assuming that the transmitting tracer 2 is held motionless for a time by the operator, the receiving pen will, for the same time, retain the position in which it is shown in Fig. 2 for the reason, hereinafter more fully explained, that the armatures 97, 97[a] are maintained, by relays 62, 72, in a state of vibration with relation to their contact stops 98, 98[a], and a pulsating current is caused to pass through magnets 79, 79[a] from local battery 80 of such strength as to establish and maintain the magnets 79, 79[a], and their respective springs 88, 88[a], in equilibrium, in their effects on armatures 84, 84[a], respectively, so that said armatures, and, therefore, the receiving pen, will retain the positions in which they are shown. On a change in the strength of the current on line, this condition of the armatures 97, 97[a] and magnets 79, 79[a] will, of course, be changed so as to move the receiving pen in the same direction and to the same extent as the transmitting tracer is moved in making such change,—it being understood, of course, that the contact rollers 25, 26, and their rheostats 27, 28, are so arranged relatively to each other that changes in the strength of the two line currents are so related to each other as to coact together to secure, through relays 62, 72, respectively, the proper movements of the receiving pen.

Let us now assume transmitting tracer 2 to be moved directly downward toward the lower edge of its writing platen,—contact roller 25 being thus moved toward the large end of its rheostat 27 and thereby decreasing the current strength on left line 58, while contact roller 26 is moved toward the small end of its rheostat 28, thus correspondingly increasing the current strength on right line 68. As the current strength is thus decreased on left line 58, the strength of the current impressed thereby on the magnet circuit of left hand relay 62 is correspondingly decreased; this condition being, of course, reversed in right hand relay 72. When the strength of the current impressed on the magnetic circuit of relay 62 is thus weakened, said relay will relax its pull on armature 97 and permit spring 96 to move said armature into better electrical contact with contact stop 98 on carrier 99 and thus close the local circuit from battery 80 through magnet 79. Magnet 79, thus strengthened, will draw its armature 84 farther into gap 83 against the pull of spring 88, and, through rock shaft 86, move receiving pen 4 downwardly, magnet 79[a] coöperating with it in doing so, as will be apparent. As magnet 79 thus draws armature 84 inwardly, however, it will, through shaft 86, pinion 110 and rack bar 109, move armature carrier 99, and with it armature 97, downwardly toward relay 62, thus decreasing the reluctance of the magnetic circuit of said relay, until armature 97 has been moved so close to the core of the relay that it will be drawn away from its contact stop 98. The local circuit from battery 80, through magnet 79, will thus be opened at these points (97, 98) and the current therein shunted through resistance 105 and weakened, said

resistance also serving to prevent sparking at these points. When this occurs, magnet 79 and relay 62 (the winding 63 of the latter being in this local circuit) will be weakened, and said relay will release its armature 97 and permit it to move into contact with contact stop 98, thus again closing this local circuit and increasing the pull of relay 62 on said armature, when the local circuit will again be opened, and so on. A vibrating condition is thus established between armature 97 and its contact stop 98 and a pulsating current caused to flow through the local circuit of proper strength to maintain the magnet 79 and its spring 88 in equilibrium, in their effects on armature 84, so that, until the next movement of the transmitting tracer, the receiving pen will be retained in the position to which it has thus been moved, which, of course, corresponds to the position to which the transmitting tracer has been moved by the operator.

If the next movement of the tracer be such as to move contact roller 25 farther toward the large end of rheostat 27, thus further decreasing the current strength on left line 58, the operation just described will be repeated, armature 84 moving still farther into gap 83 and correspondingly moving the receiving pen, and armature carrier 99 with its armature 97 being moved still farther downward, so as to decrease the reluctance of the magnetic circuit of the relay 62. In other words, on each change in current strength, the reluctance of the magnetic circuit of the relay and the magneto-motive forces impressed thereon as the main line current varies in strength are automatically adjusted relatively to each other, its reluctance being decreased, by downward movement of the armature 97 by carrier 99, as its magneto-motive force is decreased, and being increased, by upward movement of the armature, as its magneto-motive force is increased.

Assuming now that the strength of current on left line 58 is increased, by the movement of contact roller 25 toward the small end of its rheostat 27, the current impressed on the magnetic circuit of relay 62 and the pull of said relay on armature 97 will be increased, with the result that said armature will be withdrawn from contact with contact stop 98, thus opening at these points (97, 98) the local circuit from battery 80 and weakening magnet 79, and, therefore, disturbing the equilibrium between said magnet and its spring 88, in their effects upon armature 84. Spring 88 will then withdraw armature 84 from gap 83 and rotate shaft 86 in a counter-clockwise direction, and, through pinion 110 and rack bar 109, move armature carrier 99, with its armature 97, upward, thus increasing the reluctance of relay 62, until the pull of the relay 62 on said armature relaxes sufficiently to permit it to move into better electrical contact with its contact stop 98, when the vibrating condition heretofore referred to will be reëstablished between armature 97 and contact stop 98 and a pulsatory current of proper strength will be caused to flow through magnet 79 to reëstablish equilibrium between said magnet and its spring 88, in their effect on armature 84. It will, of course, be understood that the extent to which armature 84 is thus withdrawn, and, therefore, the extent of movement of the receiving pen, will depend upon the extent to which the left main line current is increased by the movement of the contract roller 25 toward the small end of its rheostat 27.

Although in this description of operation and function, reference has been made particularly to the devices on the left hand side of the receiving instrument, and to the left main line circuit, such description is equally applicable, as far as it goes, to the devices on the right hand side of the receiver and to the right main line circuit.

It will also be understood that although I have referred to the movements of the armatures 84, 84[a] as ceasing at the end of an increase or decrease in the strength of the main line currents, I did so mainly for convenience of description. In practical operation, the tracer is moved as in other telautographic apparatus; the current increases and decreases gradually as the tracer is moved laterally, and the strength of the relays 62, 72 is increased and decreased in like manner; while the magnets 79, 79[a], through the local circuits from the battery 80, respond smoothly to such variations in the main line current strength and, through their armatures 84, 84[a] and the armature carriers 99, 99[a], gradually adjust the armatures 97, 97[a] relatively to their relays 62, 72, so that the reluctance of the magnetic circuits thereof will be adjusted to the magneto-motive forces produced therein by the variations in the strength of the main line circuits.

Although the strength of the main line circuits, and, consequently, the magneto-motive forces impressed upon the magnetic circuits of the relays 62, 72, will vary considerably, yet the magnetic flux in the relays will not vary to a great extent for the reason that a slight increase in the magnetic flux, causing an increase in the pull of the relays upon their armatures 97, 97[a], respectively, will, through the action of the magnets 79, 79[a], respectively, upon the armature carriers 99, 99[a], respectively, cause the armatures 97, 97[a] of the relays to move farther away from the cores of the relays and thus increase the reluctance of their magnetic circuits. In short, the reluctance of the magnetic circuits of the relays 62, 72 is so adjusted automatically to the magneto-motive forces impressed upon said circuits, that the magnetic flux in the relays will remain practically constant,

as a result of which magnetic hysteresis is practically overcome, and the action of the relay magnets upon their armatures will bear a practically constant relation to the strength of the main line current.

It is evident that since the main line currents are used merely for the purpose of controlling the action of local circuits at the receiver for moving the receiving pen, and that the energy expended in these local circuits is not dependent upon the strength of the main line currents, the difficulty of overcoming the friction of the moving parts in the receiving instrument, existing in telautographs of the type to which the present invention relates, is minimized by the improvements of the present invention.

Although I prefer the construction and arrangement of the electrical devices as thus far described, modifications or changes may be made therein without departing from the spirit of the invention, some of which are illustrated in Figs. 5 to 9, and will be hereinafter described.

Thus far the description of the receiving pen 4 and parts connected therewith has been confined to the lateral movements of the receiving pen to and from and over the face of its record strip 5. Other movements of the receiving pen are, however, necessary, namely, first to withdraw it from the ink bottle (not shown) at its unison point, then, after it has been moved laterally to a position over the surface of the record strip 5, to move it to and from the surface of said record strip (to control the making of the record thereon) as the transmitting tracer is raised from normal position and moved to and from its writing platen 1; and to also move it again into the ink bottle during the writing operation, for a fresh supply of ink, or after the writing operation is concluded,—and all of these movements must, of course, be controlled from the transmitting instrument. The devices provided for producing these to and fro movements of the receiving pen will now be described, the description given, however, being brief, as the devices provided for these purposes constitute no part of the present invention, and are, furthermore, now well understood by those skilled in the art.

Referring to Fig. 2, it will be observed that the receiving instrument is provided with what is known as a pen lifting magnet 113, the armature 114 of which is pivotally connected by arms 115 with the bracket 116 on which the magnet 113 is supported, such pivotal connection being provided by a rod 117 passing through said bracket and through suitable openings in the lower end of the arms 115. A spring 118 connected at one end with a collar 119 fixed to the rod 117 and engaging at its other end one of the arms 115, normally tends to hold the armature 114 away from magnet 113. At their upper ends, the arms 115 are suitably secured to a pen rest 120, so that, as the armature 114 is attracted by magnet 113, or moved inwardly by spring 118, the arms 115, moving with it, will move the pen rest 120 outwardly or inwardly and thus move the receiving pen 4 away from or permit it to rest against the surface of record strip 5, as the case may be. The energization of magnet 113 is effected by battery 80 when armature 92 is biased against stop 101, said magnet being connected with said battery by a circuit consisting of wire 93 from positive pole of the battery, wire 121, windings of magnet 113, wire 122, a circuit closing device 123 hereinafter described, wire 124, wire 107, contact stop 101, armature 92, and wire 102 to the negative pole of battery 80. The circuit closing device 123 (see Fig. 4) consists of a metal rod 125 (preferably platinum) having openings in its ends in which loosely fit the terminals 122^a, 124^a of wires 122, 124, between which terminals and rod a slight amount of play is thus provided. The rod 125 and terminals 122^a, 124^a are contained in a hermetically closed tube 126, which is secured by a socket 127 (see Fig. 2) to the center of a thin iron plate or diaphragm 128 secured to the frame 129 of the relay 69 and in such proximity to the core thereof that when said relay is energized by the current traversing right main line 68, it will pull the diaphragm 128 downwardly slightly and when deënergized will release it, the tube 126 of course moving with the diaphragm. So long as the right main line current is free from vibrations, the terminals 122^a, 124^a will make good electrical contact with rod 125 with the result that the branch circuit from battery 80 through magnet 113 will be fully closed and said magnet therefore energized so as to attract its armature 114 and through arms 115 and pen rest 120, move and hold the receiving pen 4 away from the record strip 5. Should vibrations occur, however, in the right main line, diaphragm 128 will be vibrated and rod 125 disturbed repeatedly from its position of rest against terminals 122^a, 124^a, with the result that this local circuit will be repeatedly interrupted and pen lifting magnet 113 therefore be practically deënergized so that it will release its armature 114 which, with arms 115 and pen rest 120, is then retarded by spring 118, the receiving pen being thus permitted to rest against the surface of the record strip 5.

The condition of rod 125 and terminals 122^a and 124^a, with reference to contact with each other, is controlled from the transmitting instrument so that when the transmitting tracer is away from the writing platen 1 or is not depressing it, the branch circuit, just described, through pen lifting magnet 113, will be closed and said magnet energized so that its armature 114, through

the connections described, will hold the receiving pen away from its record strip 5; while, when the transmitting tracer is lowered and depresses writing platen 1, vibrations will be introduced into main line circuit 68, the effect of which, acting through relay 69, will be to interrupt this branch circuit and practically deënergize pen lifting magnet 113 so that it will permit receiving pen 4 to rest against record strip 5. The means shown for this purpose in the present case are in substance the same as those illustrated and fully described in my application Serial Number 299,413, filed February 5, 1906, so that they need not be here described at great length.

Referring now to Fig. 1, it will be observed that the transmitting instrument is provided with an interrupter magnet 130 included in a local circuit consisting, in the position shown, of master switch 30, of wire 45 from positive pole of battery 29, contact spring 38, contact plate 32, wire 46, wire 51, wire 131, winding of magnet 130, wire 132, armature 133 of said magnet, contact stop 134, wire 135, primary winding 14 of induction coil 15, wire 136, contact plate 12 on rod 8, contact stop 13, wire 53, contact plate 33 on master switch 30, contact spring 39 and wire 50 to the negative pole of battery 29. Except when the platen 1 is depressed by the transmitting tracer in writing, the contact plate 12 and contact stop 13 are out of contact with each other so that the main line currents to the receiver are steady and that on the right line will energize relay 69 so that it will draw diaphragm 128 downwardly and hold it in that position without disturbing the rod 125 and terminals 122^a, 124^a in their position of rest with relation to each other. Pen lifting magnet 113 will, therefore, be fully energized by the current from battery 80 and, therefore, through its armature 114 and parts moved thereby, move and hold the receiving pen away from its record strip 5. Whenever, however, in the operation of transmitting, the writing platen 1 is depressed by the lowering of the transmitting tracer and the pressure thereof upon it, contact plate 12 will engage contact stop 13 and thus close this local circuit through interrupter magnet 130. As the circuit is thus closed through the latter, said magnet will attract its armature 133 and withdraw it from contact with contact stop 134, thus breaking the circuit at these points, when magnet 130 will release its armature and permit it to again contact with contact stop 134, thus again closing it, and so on; the local circuit being thus repeatedly interrupted while the writing platen remains depressed. These interruptions produce, through the induction coil 15, vibrations in the right main line circuit, the result of such vibrations in the right main line being that the diaphragm 128 of relay 69 is kept in a state of vibration by said relay, so that the rod 125 and terminals 122^a, 124^a are disturbed from their position of rest with relation to each other and thus interrupt the current traversing pen lifting magnet 113 from battery 80, said magnet being, therefore, practically deënergized and permitting receiving pen 4 to rest against its record strip 5.

A condenser 137, shunted by wire 138 around the winding 71 of relay 72, provides a path for the vibrating currents in right main line 68, thereby diminishing the effect, on such vibratory currents, of the self induction of said relay.

The paper shifting mechanism at the receiving instrument, together with the means at the transmitter for controlling such shifting mechanism at the receiver, will now be described.

The paper shifting mechanism at the transmitter consists, as shown and described in my prior application heretofore referred to, of a pair of suitably mounted drawing rolls 139, 140 yieldingly engaging each other and between which the paper strip 3 passes (see Fig. 1) on its way from the writing platen 1. Lower roll 140 has at one end a ratchet wheel 141 yieldingly engaged by one end of a pawl 142 pivoted at its other end in an arm 143 projecting radially from the shaft 31 of master switch 30, so that on rocking shaft 31 in the direction of the arrow, Fig. 1, pawl 142, will rotate rolls 139, 140 a distance equal to one tooth of the ratchet and thus feed paper strip 3 forward a slight distance. It will be obvious that by rocking shaft 31 back and forth repeatedly any quantity of strip 3 may be drawn over writing platen 1.

The paper shifting mechanism at the receiving instrument consists of a reel 144, journaled in standards 145, 146, and on which the leading end of record strip 5 is wound; a spring barrel 147 provided with a gear 148 meshing with a pinion 149 on the shaft of reel 144, the tendency of said barrel being to rotate said reel to wind the strip 5 thereon; and a retarding device, normally resisting such movement of the strip, consisting of a pair of rollers 150, 151 between which said strip passes on its way from the writing field of the receiving pen 4 to the wind-up reel 144. The roller 150 is journaled in standards 152, 153, while the roller 151 is journaled in the ends of arms 154 pivotally mounted in said standards, a spring or springs 155, connected with said standards and arms, or one of each, serving to hold the roller 151 yieldingly engaged with roller 150, with the paper strip 5 between them. The barrel 147 turns on a shaft 156 journaled in standard 146 and provided with a handle 157 by which it may be rotated, and said barrel contains a coiled spring 158, the outer end whereof is connected with the bar-

rel, its inner end being connected with shaft 156. This spring is wound up by turning handle 157 and shaft 156 in a counter-clockwise direction, retrograde movement of the handle and shaft when the spring is so wound being prevented by a spring pressed pin 159 inserted in a hole in standard 146 and adapted to engage a shoulder 160 on the hub of the handle. When spring 158 is thus wound up its tendency is to turn in the direction of the arrow, Fig. 3, and rotate reel 144, but this tendency is resisted by the retarding rolls 150, 151, which in turn are normally held against rotation by means which will now be described.

Referring to Fig. 3 it will be observed that the shaft 161 of roll 150 has fixed to its left hand end a disk 162 the outer face of which is provided with two concentric rows of pins 163, 164, which are designed to be alternately engaged by a tail piece 165 with which the armature 92 of polarized relay 59 is provided, rotation of rolls 150, 151, and thereupon movement onward of strip 5, being prevented while said tail piece is so engaged with any of said pins.

The tail piece 165 is disengaged from a pin 163 or 164, as the case may be, in the following manner. As the parts are shown in Fig. 2 a positive current is on line from the transmitting instrument, and armature lever 92 is biased against contact stop 101, its tail piece 165 being therefore in engagement with a pin 163, in the outer row on disk 162. When the parts are in this position the record strip 5 may be shifted by rocking master switch 30 forward from the position in which it is shown in Fig. 1, as before described in shifting the paper at the transmitting instrument and when it is so rocked contact plates 32, 33 will pass out of contact with contact springs 38, 39, which will then contact with contact plates 36, 37, respectively, on master switch 30. As will be observed, however, contact plate 32 is electrically connected with contact plate 37, while contact plate 33 is electrically connected with contact plate 36, so that when the master switch 30 is thus rocked the polarity of the current from battery 29, in the transmitter circuits and in the main line circuits, will be reversed. Armature 92 of polarized relay 59 will therefore be moved away from stop 101 and its tail piece 165 swung inwardly out of engagement with the pin 163 in the outer row on disk 162 and into position for engagement with the following pin 164 in the inner row, the pins in the two rows being staggered as shown. Barrel 147 will then rotate reel 144 and wind strip 5 thereon until movement of the latter is arrested by engagement of tail pieces 165 with the next following pin 164 in the inner row. Master switch 30 being then rocked rearwardly to the position shown in Fig. 1, the polarity of the current on line is again reversed to positive, armature 92 reassuming the position in which it is shown in Fig. 2 and tail piece 165 passing out of engagement with the inner pin 164 and into position for engagement with the next following pin 163 in the outer row, thus permitting further movement of strip 5. This paper mechanism at the receiver is claimed in an application filed by me May 16, 1907, Serial No. 374,038.

With the paper shifting mechanism of the transmitter and receiver properly adjusted with relation to each other it will be obvious that each time the paper is shifted at the transmitter the paper at the receiver will be correspondingly shifted a certain amount, and further, that by rocking the master switch 30 back and forth, the paper at the transmitter may be shifted to any extent desired by the transmitter operator.

The modifications of the magnetic pen-controlling devices illustrated in Figs. 5 to 9 will now be described.

In Fig. 5, illustrating one of these modifications, only so much of the left hand side of a receiving instrument is illustrated as is necessary for an understanding of the construction and arrangement of the parts of the construction intended to be illustrated therein, it being understood, of course, that the parts there shown are duplicated on the right hand side of the receiving instrument. In this case the relay consists of a permanent magnet 166 having a vertically movable coil 167 included in the left main line circuit 58 from the transmitter by wire 60 from polarized relay 59 and wire 64 to ground, said coil carrying a pivoted contact plate 168, the forward end of which is adapted to play between a backstop 169 and a contact stop 170, and when in contact with the latter to close a branch circuit, hereinafter described, from the local battery 80 of the receiving instrument, which battery is common to the magnetic pen-controlling devices on both sides of the receiver, as indicated by the wires 171, 172, through which (and other wiring not shown) the magnetic pen-controlling devices at the right hand side of the receiver are connected with the battery 80. The receiving pen, in this construction, is designed to be mounted in the converging ends of a pair of pen arms 173, (only one of which is shown) each having connected with it the opposite ends of a cord which has a turn about a drum 174 which, as it is rotated by the magnetic pen-controlling devices at the receiver, in one direction or the other, moves the pen-arm 173 upwardly or downwardly, as the case may be. The magnetic pen-controlling devices in the present case for so rotating the drum 174 consist of a pair of solenoids 175, 176 having vertically movable armatures connected by

a cord 177 passing over pulleys 178, and having a turn about pulley 179 fixed to the side of drum 174 or to the shaft carrying it. The pulley 179 has also connected with it a cord 180 which in turn is connected with a spring 181 having its lower end connected with contact plate 168. Both of these solenoids 175, 176 are included in a local circuit from battery 80 consisting of wires 182, 183, from the positive pole of said battery to the solenoid 176, wire 184, from the latter to solenoid 175, and wire 185 therefrom to contact stop 101, armature 92 of relay 59, and wire 186 to the negative pole of said battery. The winding of solenoid 175 is of fewer turns than the winding of solenoid 176, so that when the two windings are in series, as in the position in which relay contact 168 is shown, the solenoid 176 will be of greater strength than solenoid 175 and thus rotate the pen drum 174 in a clockwise direction, thereby moving the pen arm 173 downwardly. When contact 168 engages contact stop 170, however, a shunt circuit, consisting of wire 187, contact plate 168, contact stop 170, and wire 188, is formed around solenoid 176, so that solenoid 175 will then become the stronger of the two and draw its armature or plunger downwardly and thus rotate the pen drum in a counter-clockwise direction.

The operation of this apparatus is as follows:—The parts as shown in Fig. 5 are in normal position with both of the solenoids 175, 176 in circuit with battery 80. Current shunted into the main line circuit 58 from the transmitter and passing through coil 167, has a tendency to cause that coil to move downwardly in its magnetic field, and thus carry contact plate 168 toward contact stop 170 against the pull of spring 181, and, if the current be strong enough, it will cause said contact plate to engage contact stop 170 and thus close the shunt circuit around solenoid 176, consisting of wire 187, contact 170, and wire 188. When this occurs, the current flowing through solenoid 176 will be diminished and that flowing through solenoid 175 increased in strength. Solenoid 175 then becomes the stronger of the two, with the result that its armature or plunger will move farther into the coil, rotating drum 179 in a counter-clockwise direction, winding up cord 180 and increasing the tension of spring 181 until it is sufficient to overcome the effect of the line current upon coil 167, when it will move coil 167 upward and separate contact 170 and plate 168, thus causing an increase in the strength of the current flowing through solenoid 176 by opening the shunt around this solenoid, thus making solenoid 176 the stronger of the two, and, through its action, causing the drum 179 to rotate in a clockwise direction and weakening spring 181 until coil 167 is drawn farther into the field of magnet 166 by the line current, and contact 170 and plate 168 contact; and so on.

It is evident from the above description that the device in its attempt to maintain a balance between the upward tension of spring 181 and the downward pull of the coil 167 will cause the drum 179 to oscillate and give the pen arm 173 a reciprocating motion. To overcome this objectionable feature, the contact plate 168 is caused to vibrate when it is first brought into contact with contact stop 170, as will now be described. The positive line current after leaving coil 167 will flow to earth through a resistance coil 189 which is introduced in the local circuits of solenoids 175, 176 and battery 80. This coil 189 serves to introduce a variable counter electro-motive force in the earth circuit of line, in the following manner: With solenoids 175, 176 normally in circuit, the current flowing through coil 189 will be at its minimum, consequently the difference of potential at the terminals of coil 189 will be at its minimum as far as the local circuits are concerned. When, however, plate 168 contacts with contact stop 170, shunting out solenoid 176, the strength of the local current, and, consequently, the difference of potential at the terminals of coil 189, will increase and oppose the line current in coil 167, thus weakening the current flowing through coil 189 and allowing spring 180 to move plate 168 out of contact with contact stop 170, thus opening the shunt circuit around solenoid 176, and causing a decrease in the drop of voltage around coil 189, thus allowing the line current to increase in strength, moving coil 167 downward until plate 168 and contact stop 170 contact, when the shunt circuit around solenoid 176 will be closed, the main line current weakened, etc. A vibrating condition will thus be established at contacts 168, 170, and the preponderance of power being alternately given to solenoids 175, 176, the conditions adjusting themselves to a state of equilibrium and the pen arm 173 brought substantially to a state of rest.

An increase in the strength of the line current flowing through coil 167 will first cause an increase in the downward pull of coil 167, thus bringing plate 168 into more permanent contact with contact stop 170 and increasing the mean strength of the currents flowing through solenoid 175, and decreasing the mean strength of the currents flowing through solenoid 176. The action of solenoid 175 in moving drum 179 and pen arm 173, and increasing the tension of spring 181, will cause plate 168 to contact less permanently with contact stop 170 and equilibrium will again be established.

The plungers of solenoids 175, 176 may be

adapted to be used as dash-pots to moderate the movement of parts to prevent too violent an action.

In the modification illustrated in Figs. 6 and 7, one side (the left) of a transmitting instrument (Fig. 6) and the corresponding side of a receiving instrument (Fig. 7) are shown. The source of energy for the main line circuit from the transmitting instrument consists of a battery 29, the negative pole of which is connected with ground and the positive pole of which is connected by a wire 45× with a variable resistance rheostat 27×, as distinguished from the variable potential rheostat 27 of Fig. 1. The transmitting tracer of this instrument is mounted in pen arms and pen levers as in Fig. 1, the lever 21 shown being provided with a contact roller 25 engaging rheostat 27×, and the current from battery 29 passing, by this contact roller 25 and lever 21, into left main line circuit 58 leading to the receiving instrument. It will be understood that as contact roller 25 moves to the right, the strength of current on main line 58 is increased, and as it moves to the left is decreased. For convenience of illustration and description, no master switch is shown in Fig. 6. For the same reason many of the receiver parts illustrated in Fig. 1 are omitted in Fig. 7.

The left main line circuit in the receiver consists of wire 58, pen arm 77, contact roller 190, rheostat 191, wire 192, one winding 61 of a relay 62, and wire 193 to ground. Magnet 79 of this construction is energized from local battery 80 by a circuit consisting of wire 194 from the positive pole of said battery, the winding of said magnet 79, wire 195, the winding 63 of relay 62, wire 196, the armature 197 of said relay, contact stop 198, and wires 199, 200 to the negative pole of battery 80. A shunt circuit is also provided around armature 197 and contact stop 198 consisting of wires 201, a resistance 202 and wires 203 and 200.

The operation of this receiver apparatus is as follows: Assuming the parts to be in the position in which they are shown in Fig. 7, and current to be on main line 58, and assuming the transmitting tracer to be at rest for a time, armature 197 will be in a state of vibration with relation to contact stop 198, so that a pulsating current from battery 80 is passing through magnet 79 which has the effect, as more fully described in connection with Fig. 2, of establishing and maintaining, for that time, an equilibrium between said magnet 79 and its spring 88 in their effects upon the armature 84, so that the pen arm and pen-arm lever 75, 77 will retain the positions in which they are shown. If now the main line current be reduced in strength, the magnetic flux in relay 62 will be correspondingly weakened and the pull of said relay on armature 197 will be relaxed, so that said armature will move into better electrical contact with contact stop 198, with the result that the circuit from battery 80 through magnet 79 will be closed and said magnet strengthened so as to draw its armature 84 farther into the gap 83. As armature 84 is thus drawn inwardly, however, the pen arm lever 77, moving with it, will move contact roller 190 downwardly toward the lower end of rheostat 191, thereby reducing the resistance in the main line circuit and correspondingly strengthening relay 62, which is also strengthened by the current passing through its winding 63 from the circuit from local battery 80. The result of such increase in the strength of relay 62 is to cause it to increase its pull on armature 197 and move it away from contact 198, thus opening at these points (197, 198) the circuit through magnet 79 and causing the current therein to pass through the shunt circuit 201, 202, and 203. The current, passing through resistance 202, will be weakened and magnet 79 therefore weakened, with the result that inward movement of armature 84 will cease. Weakening of the current through magnet 79 also results in weakening relay 62, as the winding 63 thereof is included in this circuit, so that said relay will release armature 197 and permit it to again contact with contact stop 198, thus closing the circuit at these points through magnet 79 and also through winding 63 of relay 62, when armature 197 will be again drawn by the latter away from contact 198, thus again opening the circuit, and so on. A vibrating condition is thus established between armature 197 and contact stop 198, which results in a pulsating current from battery 80 passing through magnet 79 and establishing an equilibrium between said magnet and spring 88 in their effects on armature 84. If now the current on the main line 58 be increased, the magnetomotive force in the magnetic circuit of relay 62 will be correspondingly increased, and said relay will attract its armature 197 so as to disengage it from contact stop 198, thus opening at these points the local circuit through magnet 79, which will be thus weakened and therefore permit its spring 88 to withdraw armature 84 from the gap 83. As armature 84 is thus withdrawn from gap 83, however, contact roller 190 will move upwardly along the rheostat 191, thereby gradually increasing the resistance in the main line circuit at the receiver, with the result that relay 62 will be weakened and finally release its armature 197 and permit it to move into better electrical contact with contact stop 198, thus closing the circuit at these points through magnet 79. The closing of this circuit, however, has the effect of also increasing the strength of relay 62, as

said circuit includes the windings 63 of said relay, so that said relay will again draw its armature 197 away from contact stop 198 and again open the circuit at these points through magnet 79, and so on, a vibrating condition being thus established between armature 197 and contact stop 198, and a pulsating current caused to pass through magnet 79 which has the effect of establishing an equilibrium between said magnet and its spring 88 in their effect upon armature 84 and therefore upon the pen arm and lever 75 and 77.

In Figs. 8 and 9 are illustrated, respectively, the left hand side of a transmitting instrument and the left hand side of a receiving instrument, these two instruments being interchangeable in the sense that each may be used either as a transmitter or a receiver by suitably shifting the master switch 204 or 204[a], as hereinafter will more fully appear. The source of energy for the main line currents is the battery 205, Fig. 8, (lettered 205[a] in Fig. 9) when the instrument is used as a transmitter; this battery becoming a local battery, controlling the magnetic pen-controlling devices, when the instrument is used as a receiver. For convenience, the apparatus shown in Fig. 8 will be described as the transmitting apparatus and that illustrated in Fig. 9 as the receiving apparatus, the same reference numerals being applied to the corresponding parts in the two figures, except that in Fig. 9 they are accompanied by the reference letter "a."

With the master switch 204 in the position shown in Fig. 8, the variable resistance rheostat 206 of Fig. 8 is connected with positive pole of battery 205 by wires 207, contact 208, contact plate 209 of master switch 204, and wire 210. The transmitting tracer is mounted, like the receiving pen of Fig. 2, in pen arms 211 and pen arm levers 212 (one of each being shown), and said lever 212 is provided with a contact roller 213 bearing against the rheostat 206. The main line circuit from the transmitter consists of contact roller 213, lever 212, wire 214, the winding 215 of a relay 216 (like the relay 62 illustrated in Fig. 2 and heretofore described), and wire 58 leading to the transmitting instrument. When the transmitting tracer is moved, contact roller 213 moving with it will, as it moves to the left, along the rheostat 206, reduce the resistance of this main line circuit, thus increasing the strength of the current on main line 58, while as it moves to the right, it will decrease the strength of such current.

The main line circuit in the receiving instrument illustrated in Fig. 9, consists of wire 58, the winding 215[a] of relay 216[a], wire 214[a], pen arm lever 212[a], contact roller 213[a] carried thereby, variable resistance rheostat 206[a], wire 217[a], contact plate 218[a] of master switch 204[a], contact 219[a] and wires 220[a], 221[a] to ground. This receiving instrument is provided with a magnet 222[a], like the magnet 79 of Fig. 2, and as the construction and method of operation of this magnet are the same as said magnet 79, no detailed description thereof is here necessary. This magnet 222[a] is energized by a local circuit from the battery 205[a] of the receiver (which when the receiver is used as a transmitter becomes the main line battery, as before stated), consisting of wire 210[a] from the positive pole of said battery, contact plate 209[a] of master switch 204[a], contact 223[a], wires 224[a], 225[a], contact stop 226[a], armature 227[a] of relay 216[a], wire 228[a], winding 229[a] of relay 216[a], wire 230[a], the winding of magnet 222[a], and wires 231[a], 232[a] to the negative pole of battery 205[a].

The operation of this apparatus is as follows: With the master switches 204, 204[a] in the positions in which they are illustrated in Figs. 8 and 9, as the current on the main line 58 is increased, relay 216[a], as in the case of the relay 62 of Fig. 7, will attract its armature 227[a] and move it away from its contact stop 233[a], thus opening the local circuit through magnet 222[a] and causing the current therein to pass through the resistance 234[a]. The magnet 222[a] will, therefore, be weakened so as to permit its spring 235[a] to withdraw its armature 236[a] from the gap 237[a]. As the armature is thus moved, however, contact roller 213[a] will move to the left or upwardly along the rheostat 206[a], thus increasing the resistance in the main line circuit with the result that the relay 216[a] will be weakened and tend to permit its armature 227[a] to again move into contact with contact stop 226[a], thus closing at these points the local circuit through magnet 222[a]. As this local circuit is closed, however, relay 216[a] is strengthened by the current therein which passes through the winding 229[a] of said relay, and, as a consequence, said relay tends to withdraw armature 227[a] from contact stop 226[a] and thus open this local circuit at these points; and so on, a vibratory condition such as heretofore described in connection with the preceding figures of the drawings being established between armature 227[a] and its contact stop 226[a], which has the effect of causing a pulsating current to pass through magnet 222[a] which will establish an equilibrium between that magnet and its spring 235[a] in their effects on the armature 236[a]. When the main line current is weakened, the operation of the relay 216[a] is reversed, that is, it releases its armature 227[a] so as to permit it to move into better electrical contact with contact stop 226[a] and to thus close the local circuit from battery 205[a] through magnet 222[a], this circuit being opened, however, when the relay is strengthened by the current from this battery passing through

the winding 229[a] thereof and the vibratory condition between armature 227[a] and its contact 226[a] is reëstablished.

In view of the detailed description of the operation of the apparatus in the preceding figures of the drawings, no further description is deemed necessary of the construction and operation of the apparatus illustrated in Figs. 8 and 9 except to point out that by moving master switch 204[a] from the position in which it is shown in Fig. 9, and also moving master switch 204 from the position in which it is shown in Fig. 8,—in other words, reversing these two switches, the apparatus of Fig. 9 may be used as a transmitter, and the apparatus of Fig. 8 as a receiver.

What I claim is:—

1. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines adjustable to such variations and controlling said circuit connections, and means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, substantially as described.

2. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines adjustable to such variations and controlling said circuit connections, and means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, substantially as described.

3. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines adjustable to such variations and having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, and means controlled by the pen-controlling devices for adjusting the relays as aforesaid conjointly with the movements of the receiving pen, substantially as described.

4. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines adjustable to such variations and having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, and means controlled by the pen-controlling devices for adjusting the relays as aforesaid conjointly with the movements of the receiving pen, substantially as described.

5. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines adjustable to such variations and controlling said circuit connections, and means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, said relays and adjustable means being so constructed and correlated that as the main line currents thus vary in strength the reluctance and magneto-motive force of the magnetic circuits of the relays will be maintained in a substantially fixed ratio to each other and the magnetic flux in said circuits be maintained substantially constant, substantially as described.

6. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines adjustable to such variations and controlling said circuit connections, and means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, said relays and adjusting means being so constructed and correlated that as the main line currents thus vary in strength the reluctance and magneto-motive force of the magnetic circuits of the relays will be maintained in a substantially fixed ratio to each other and the magnetic flux in said circuits be maintained substantially constant, substantially as described.

7. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting

tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines adjustable to such variations and controlling said circuit connections, and means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, said relays and adjusting means being so constructed and correlated that as a relay is so adjusted a vibratory condition is established therein and a pulsating current thus caused to pass through the magnetic pen-controlling devices corresponding to such relay which will maintain in equilibrium the opposing forces thereof in their effect on the receiving pen, substantially as described.

8. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines adjustable to such variations and controlling said circuit connections, and means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, said relays and adjusting means being so constructed and correlated that as a relay is so adjusted a vibratory condition is established therein and a pulsating current thus caused to pass through the magnetic pen-controlling devices corresponding to such relay which will maintain in equilibrium the opposing forces thereof in their effect on the receiving pen, substantially as described.

9. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines adjustable to such variations and having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, and means controlled by the pen-controlling devices for adjusting the relays as aforesaid conjointly with the movements of the receiving pen, said relays and adjusting means being so constructed and correlated that as a relay is so adjusted a vibratory condition is established between its circuit closing device and the circuit terminal engaged by the latter and a pulsating current thus caused to pass through the magnetic pen-controlling devices corresponding to such relay which will maintain in equilibrium the opposing forces thereof in their effect on the receiving pen, substantially as described.

10. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines adjustable to such variations and having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, and means controlled by the pen-controlling devices for adjusting the relays as aforesaid conjointly with the movements of the receiving pen, said relays and adjusting means being so constructed and correlated that as a relay is so adjusted a vibratory condition is established between its circuit closing device and the circuit terminal engaged by the latter and a pulsating current thus caused to pass through the magnetic pen-controlling devices corresponding to such relay which will maintain in equilibrium the opposing forces thereof in their effect on the receiving pen, substantially as described.

11. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines adjustable to such variations and having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, means controlled by the pen-controlling devices for adjusting the relays as aforesaid conjointly with the movements of the receiving pen, and shunt circuits, containing resistances, around the circuit closing devices of the relays and the circuit terminals which they engage, substantially as described.

12. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines adjustable to such variations and having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, means controlled by the pen-controlling devices for ad-

justing the relays as aforesaid conjointly with the movements of the receiving pen, and shunt circuits, containing resistances, around the circuit closing devices of the relays and the circuit terminals which they engage, substantially as described.

13. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines adjustable to such variations and controlling said circuit connections, means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, and means for retarding the movements in opposite directions of the movable parts of said pen-controlling devices, substantially as described.

14. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines adjustable to such variations and controlling said circuit connections, means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, and dash pots for retarding the movements in opposite directions of the movable parts of said pen-controlling devices, substantially as described.

15. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, said circuit closing devices being adjustable to and from said magnets as the main line currents thus vary in strength, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said circuit closing devices conjointly with the movements of the receiving pen, substantially as described.

16. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, said circuit closing devices being adjustable to and from said magnets as the main line currents thus vary in strength, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said circuit closing devices conjointly with the movements of the receiving pen, substantially as described.

17. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, said circuit closing devices being adjustable to and from said magnets as the main line currents thus vary in strength, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said circuit closing devices conjointly with the movements of the receiving pen, said relay magnets, circuit closing devices and adjusting means being so constructed and correlated that as said circuit closing devices are so adjusted the reluctance and magnetomotive force of the magnetic circuits of the relays will be maintained in a substantially fixed ratio to each other and the magnetic flux in said circuits be maintained substantially constant, substantially as described.

18. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main line, relays in the main lines having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, said circuit closing devices being adjustable to and from said magnets as the main line currents thus vary in strength, whereby said relays are adjusted to such variations, and means controlled by the pen-controlled devices for so adjusting said circuit closing devices conjointly with the movements of the receiving pen, said relay magnets, circuit

closing devices and adjusting means being so constructed and correlated that as said circuit closing devices are so adjusted the reluctance and magneto-motive force of the magnetic circuits of the relays will be maintained in a substantially fixed ratio to each other and the magnetic flux in said circuits be maintained substantially constant, substantially as described.

19. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, said circuit closing devices being adjustable to and from said magnets as the main line currents thus vary in strength, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said circuit closing devices conjointly with the movements of the receiving pen, said relay magnets, circuit closing devices and adjusting means being so constructed and correlated that as a circuit closing device is thus adjusted a vibratory condition is established between it and the circuit terminal engaged by it and a pulsating current thus caused to pass through the magnetic pen-controlling devices corresponding to its relay which will maintain in equilibrium the opposing forces thereof in their effect on the receiving pen, substantially as described.

20. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines having circuit closing devices actuated by their magnets and adapted to engage terminals of and thus control said circuit connections, said circuit closing devices being adjustable to and from said magnets as the main line currents thus vary in strength, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said circuit closing devices conjointly with the movements of the receiving pen, said relay magnets, circuit closing devices and adjusting means being so constructed and correlated that as a circuit closing device is thus adjusted a vibratory condition is established between it and the circuit terminal engaged by it and a pulsating current thus caused to pass through the magnetic pen-controlling devices corresponding to its relay which will maintain in equilibrium opposing forces thereof in their effect on the receiving pen, substantially as described.

21. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines, carriers bearing contacts constituting terminals of said circuit connections and also movable circuit closing devices actuated by the magnets of the relays and adapted to engage said contacts and thus control said circuit connections, said carriers and with them said circuit closing devices being adjustable to and from the relay magnets as the main line currents thus vary, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said carriers conjointly with the movements of the receiving pen, substantially as described.

22. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines, carriers bearing contacts constituting terminals of said circuit or circuits and also movable circuit closing devices actuated by the magnets of the relays and adapted to engage said contacts and thus control said circuit connections, said carriers and with them said circuit closing devices being adjustable to and from the relay magnets as the main line currents thus vary, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said carriers conjointly with the movements of the receiving pen, substantially as described.

23. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines, carriers bearing contacts constituting terminals of said circuit connections and also movable circuit closing devices actuated by the magnets of the relays and adapted to engage said contacts and thus control

said circuit connections, said carriers and with them said circuit closing devices being adjustable to and from the relay magnets as the main line currents thus vary, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said carriers conjointly with the movements of the receiving pen, said relay magnets, carriers, circuit closing devices and adjusting means being so constructed and correlated that as said carriers and their circuit closing devices are thus adjusted the reluctance and magneto-motive force of the magnetic circuits of the relays will be maintained in a substantially fixed ratio to each other and the magnetic flux in said circuits be maintained substantially constant, substantially as described.

24. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines, carriers bearing contacts constituting terminals of said circuit connections and also movable circuit closing devices actuated by the magnets of the relays and adapted to engage said contacts and thus control said circuit connections, said carriers and with them said circuit closing devices being adjustable to and from the relay magnets as the main line currents thus vary, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said carriers conjointly with the movements of the receiving pen, said relay magnets, carriers, circuit closing devices and adjusting means being so constructed and correlated that as said carriers and their circuit closing devices are thus adjusted the reluctance and magneto-motive force of the magnetic circuits of the relays will be maintained in a substantially fixed ratio to each other and the magnetic flux in said circuits be maintained substantially constant, substantially as described.

25. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines, carriers bearing contacts constituting terminals of said circuit connections and also movable circuit closing devices actuated by the magnets of the relays and adapted to engage said contacts and thus control said circuit connections, said carriers and with them said circuit closing devices being adjustable to and from the relay magnets as the main line currents thus vary, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said carriers conjointly with the movements of the receiving pen, said relay magnets, carriers, circuit closing devices and adjusting means being so constructed and correlated that as a circuit closing device is thus adjusted through its carrier a vibratory condition is established between it and the circuit terminal engaged by it and a pulsating current thus caused to pass through the magnetic pen-controlling devices corresponding to its relay which will maintain in equilibrium the opposing forces thereof in their effect on the receiving pen, substantially as described.

26. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main lines, carriers bearing contacts constituting terminals of said circuit connections and also movable circuit closing devices actuated by the magnets of the relays and adapted to engage said contacts and thus control said circuit connections, said carriers and with them said circuit closing devices being adjustable to and from the relay magnets as the main line currents thus vary, whereby said relays are adjusted to such variations, and means controlled by the pen-controlling devices for so adjusting said carriers conjointly with the movements of the receiving pen, said relay magnets, carriers, circuit closing devices and adjusting means being so constructed and correlated that as a circuit closing device is thus adjusted through its carrier a vibratory condition is established between it and the circuit terminal engaged by it and a pulsating current thus caused to pass through the magnetic pen-controlling devices corresponding to its relay which will maintain in equilibrium the opposing forces thereof in their effect on the receiving pen, substantially as described.

27. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines adjustable to such variations and controlling said circuit connec-

tions, the magnet of each relay having two windings, one of which is included in the main line in which the relay is located, and the other in said circuit connections, and means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, substantially as described.

28. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main line adjustable to such variations and controlling said circuit connections, the magnet of each relay having two windings, one of which is included in the main line in which the relay is located, and the other in said circuit connections, and means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, substantially as described.

29. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, circuit connections therefor, relays in the main lines adjustable to such variations and controlling said circuit connections, the magnet of each relay having two windings of a different number of turns with the one of many turns included in the main line in which the relay is located and the other in said circuit connections, and means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, substantially as described.

30. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising magnetic pen-controlling devices, local circuit connections therefor having a source of electric energy separate from that of the main lines, relays in the main line adjustable to such variations and controlling said circuit connections, the magnet of each relay having two windings of a different number of turns with the one of many turns included in the main line in which the relay is located and the other in said circuit connections, and means controlled by the pen-controlling devices for so adjusting the relays conjointly with the movements of the receiving pen, substantially as described.

31. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising, for each main line, a pen-controlling magnet having an arc-shaped gap between its pole pieces and an oscillating armature movable therein in one direction by the magnet, means for moving said armature in the opposite direction, a circuit for said magnet, a relay in said main line adjustable to the variations in current strength therein and controlling said circuit, and means controlled by the pen-controlling magnet for so adjusting said relay conjointly with the movements of the receiving pen, substantially as described.

32. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising, for each main line, a pen-controlling magnet having an arc-shaped gap between its pole pieces and an oscillating armature movable therein in one direction by the magnet, means for moving said armature in the opposite direction, a local circuit for said magnet having a source of electric energy separate from that of said main line, a relay in said main line adjustable to the variations in current strength therein and controlling said circuit, and means controlled by the pen-controlling magnet for so adjusting said relay conjointly with the movements of the receiving pen, substantially as described.

33. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising, for each main line, a pen-controlling magnet having an arc-shaped gap between its pole pieces and an oscillating armature movable therein in one direction by the magnet, means for moving said armature in the opposite direction, a circuit for said magnet, a relay in said main line having a circuit closing device actuated by the magnet of said relay and adapted to engage a terminal of and thus control said circuit, said circuit closing device being adjustable to and from the magnet of the relay as the current in said main line varies in strength, whereby said relay is adjusted to such variations, and means controlled by the pen-controlling

magnet for so adjusting said circuit closing device conjointly with the movements of the receiving pen, substantially as described.

34. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising, for each main line, a pen-controlling magnet having an arc-shaped gap between its pole pieces and an oscillating armature movable therein in one direction by the magnet, means for moving said armature in the opposite direction, a local circuit for said magnet having a source of electric energy separate from that of said main line, a relay in said main line having a circuit closing device actuated by the magnet of said relay and adapted to engage a terminal of and thus control said circuit, said circuit closing device being adjustable to and from the magnet of the relay as the current in said main line varies in strength, whereby said relay is adjusted to such variations, and means controlled by the pen-controlling magnet for so adjusting said circuit closing device conjointly with the movements of the receiving pen, substantially as described.

35. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising, for each main line, a pen-controlling magnet having an arc-shaped gap between its pole pieces and an oscillating armature movable therein in one direction by the magnet, means for moving said armature in the opposite direction, a circuit for said magnet, a relay in said main line, a carrier bearing a contact constituting a terminal of said circuit and also a movable circuit closing device actuated by the magnet of the relay and adapted to engage said contact and thus control said circuit, said carrier and with it said circuit closing device being adjustable to and from the relay magnet as the current in said main line varies in strength, whereby said relay is adjusted to such variations, and means controlled by the pen-controlling magnet for so adjusting said carrier conjointly with the movements of the receiving pen, substantially as described.

36. In a telautographic system, the combination with means for varying the strength of the main line currents in accordance with the lateral movements of the transmitting tracer, of means for moving the receiving pen laterally in accordance with such variations, comprising, for each main line, a pen-controlling magnet having an arc-shaped gap between its pole pieces and an oscillating armature movable therein in one direction by the magnet, means for moving said armature in the opposite direction, a local circuit for said magnet having a source of electric energy separate from that of said main line, a relay in said main line, a carrier bearing a contact constituting a terminal of said circuit and also a movable circuit closing device actuated by the magnet of the relay and adapted to engage said contact and thus control said circuit, said carrier and with it said circuit closing device being adjustable to and from the relay magnet as the current in said main line varies in strength, whereby said relay is adjusted to such variations, and means controlled by the pen-controlling magnet for so adjusting said carrier conjointly with the movements of the receiving pen, substantially as described.

In testimony whereof, I have hereunto set my hand, in the presence of two subscribing witnesses.

GEORGE S. TIFFANY.

Witnesses:
J. A. GRAVES,
PHILIP N. TILDEN.