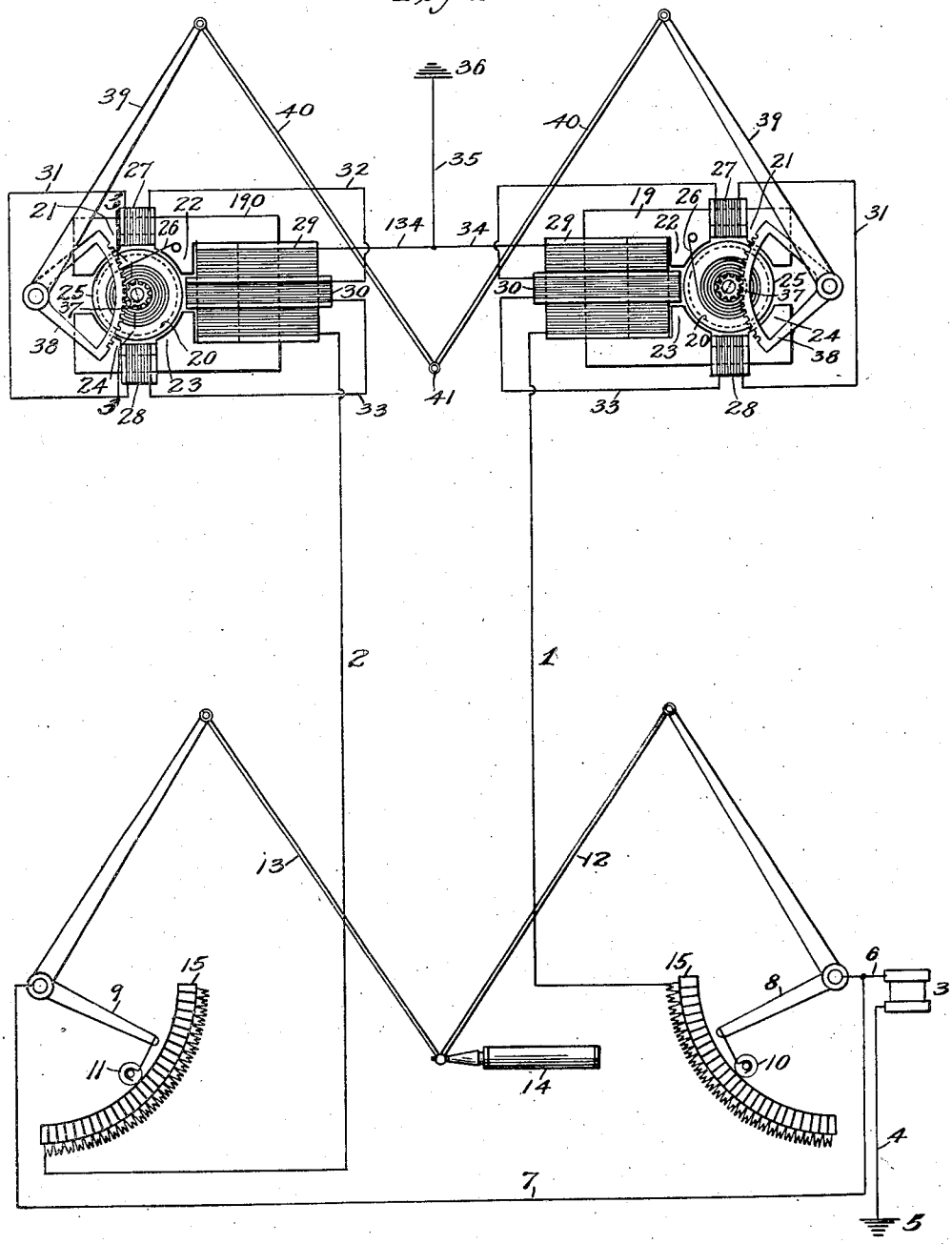
July 7, 1925. 1,544,871

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TELAUTOGRAPH

Filed Oct. 25, 1918 6 Sheets-Sheet 1

Fig. 1.



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TELAUTOGRAPH

Filed Oct. 25, 1918 6 Sheets-Sheet 2

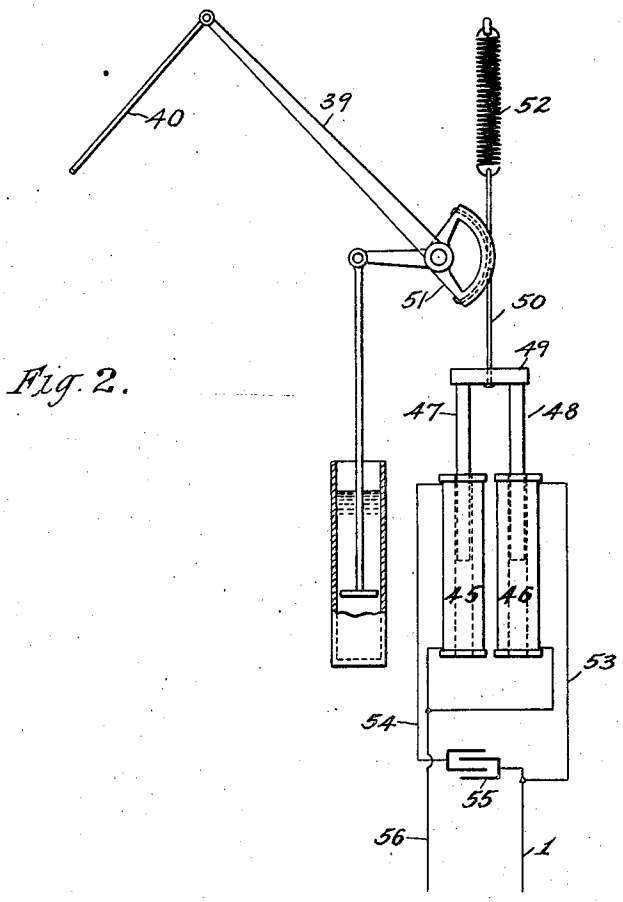
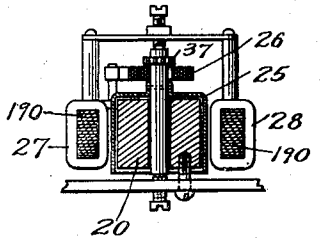


Fig. 2.

Fig. 3.



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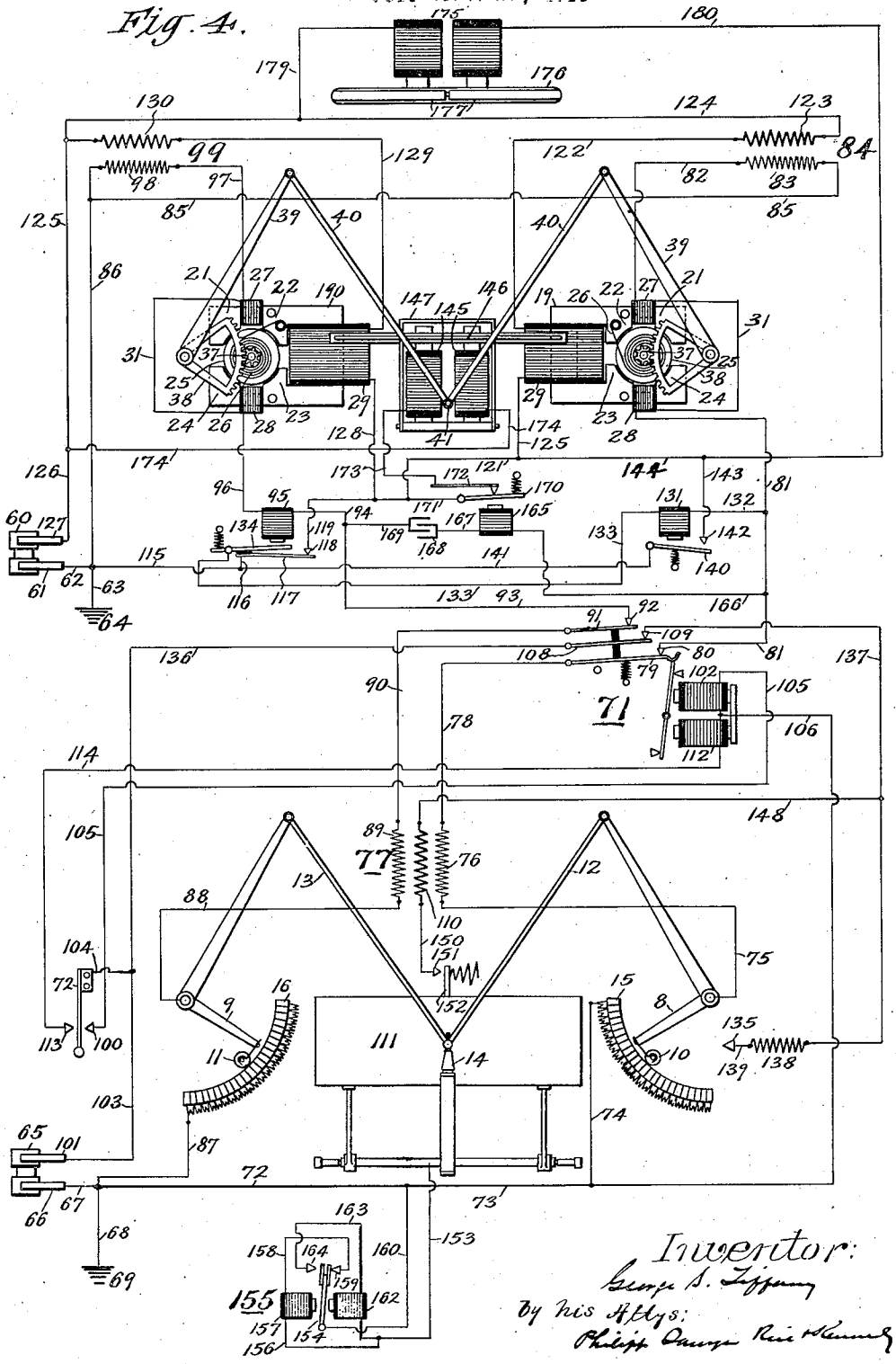
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TELAUTOGRAPH

Filed Oct. 25, 1918 6 Sheets-Sheet 3

Fig. 4.



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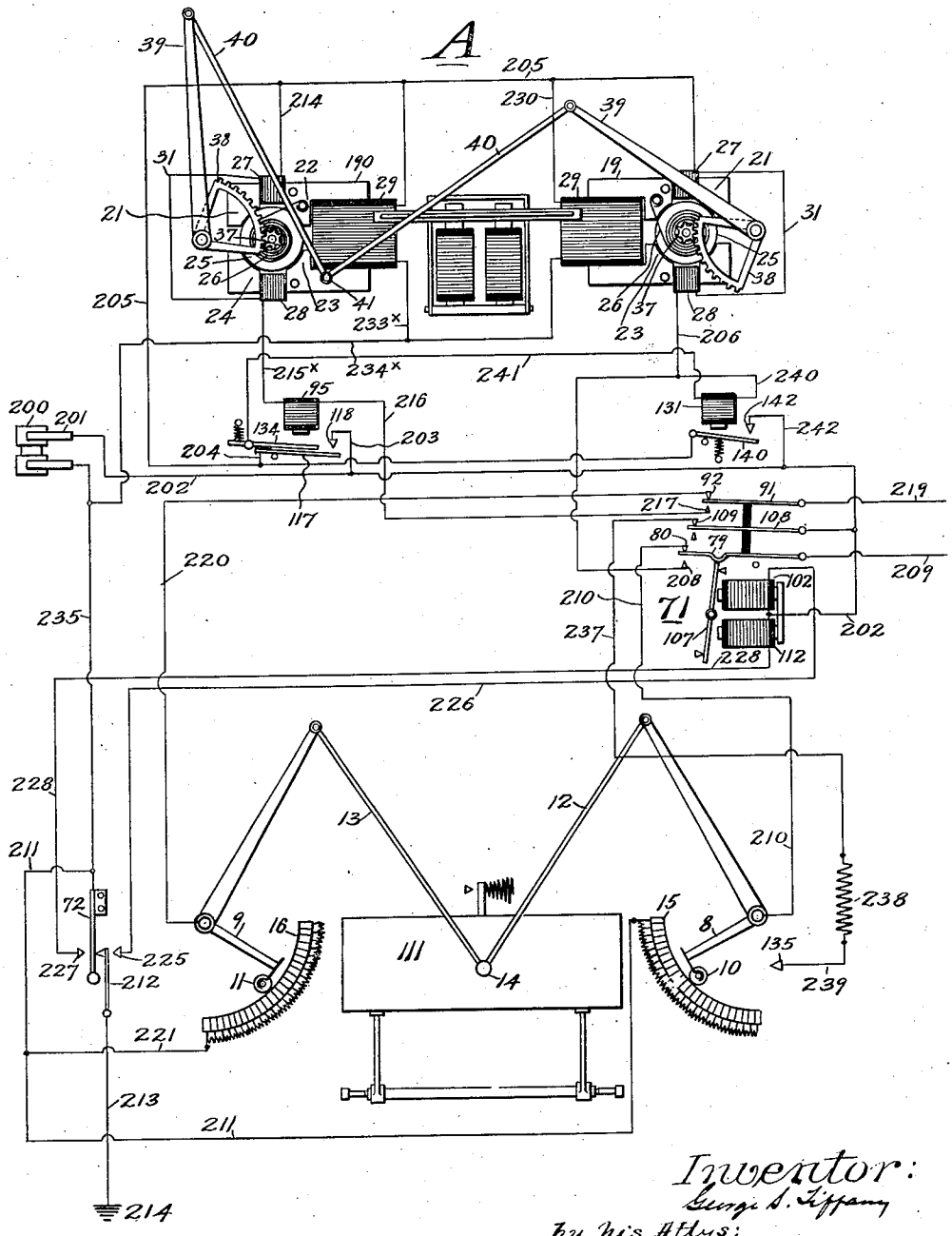
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TELAUTOGRAPH

Filed Oct. 25, 1918 6 Sheets-Sheet 4

Fig. 5.



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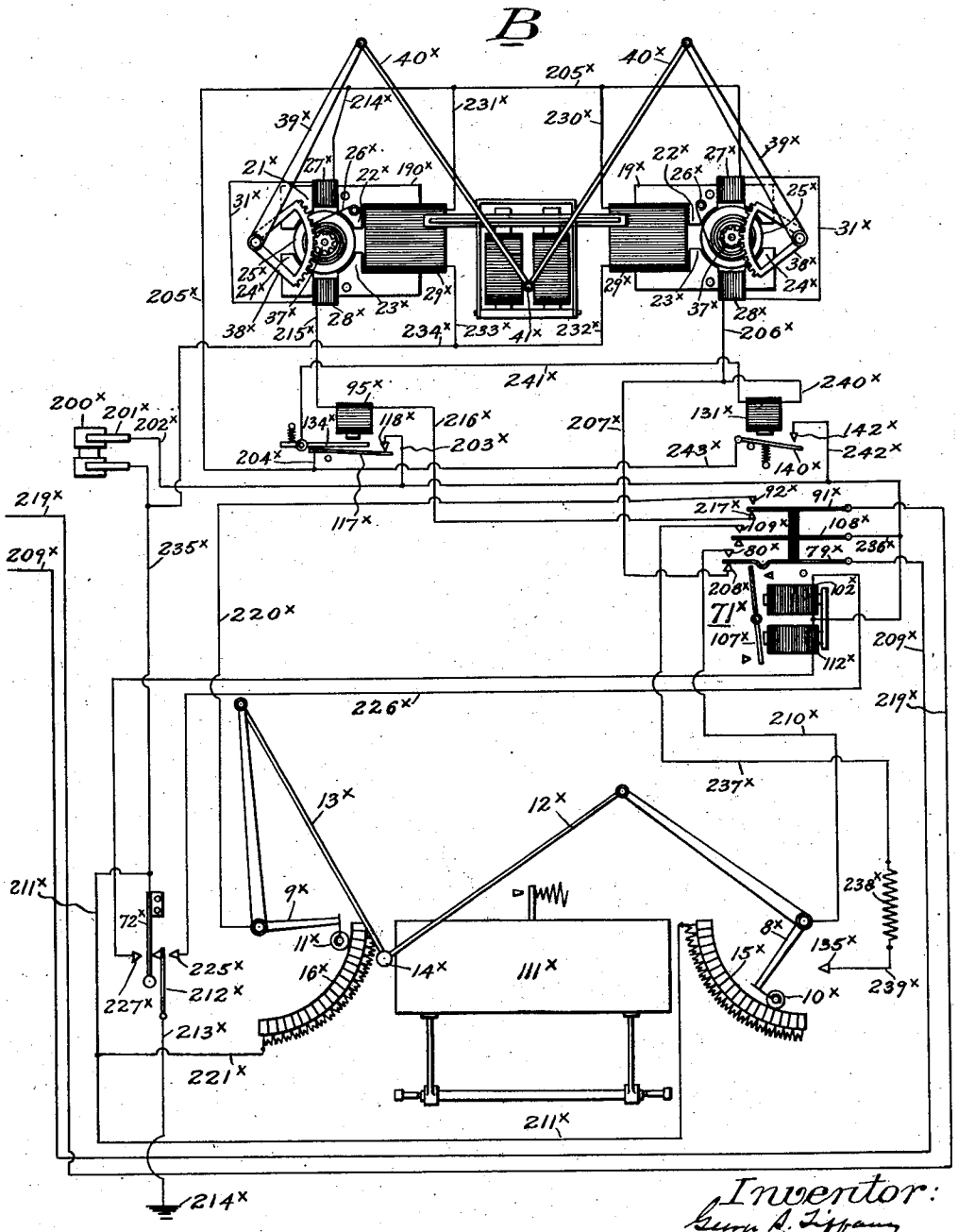
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TELAUTOGRAPH

Filed Oct. 25, 1918 6 Sheets-Sheet 5

Fig. 6.



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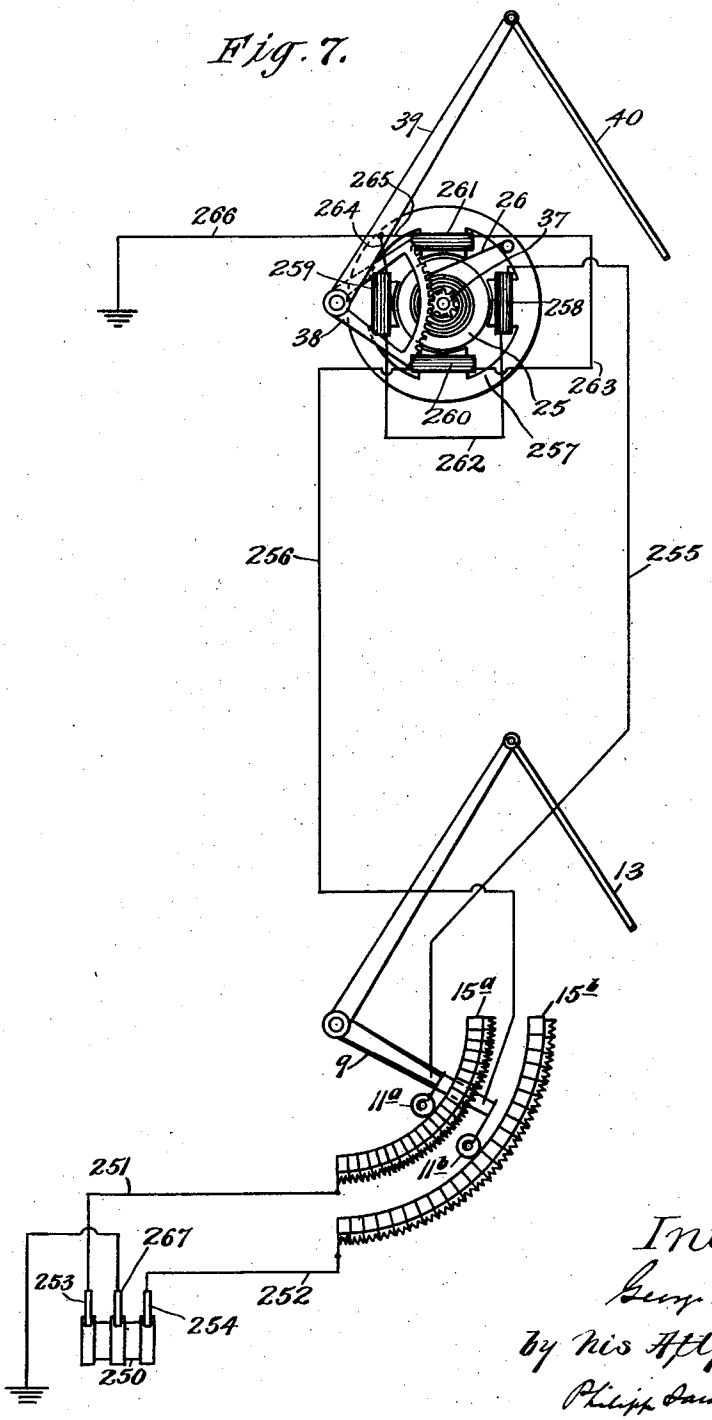
July 7, 1925. 1,544,871

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TELAUTOGRAPH

Filed Oct. 25, 1918 5 Sheets-Sheet 6

Fig. 7.



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UNITED STATES PATENT OFFICE.

GEORGE S. TIFFANY, OF SUMMIT, NEW JERSEY, ASSIGNOR TO TELAUTOGRAPH CORPORATION, OF RICHMOND, VIRGINIA, A CORPORATION OF VIRGINIA.

TELAUTOGRAPH.

Application filed October 25, 1918. Serial No. 259,617.

To all whom it may concern:

Be it known that I, GEORGE S. TIFFANY, a citizen of the United States, residing at 43 Oak Ridge Avenue, 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 telautograph systems and more particularly such systems in which the writing movements of the receiving pen, in accordance with the writing movements of the transmitting tracer, are effected by variations in the strength of the currents traversing the main line, which variations are in turn controlled by the transmitting tracer.

Heretofore telautographic systems have been dependent for their operation upon direct currents and in the many places where the only current supply available is an alternating one, it has been necessary to interpose between the service lines of such current and the telautographic system some means for converting the alternating current into direct current.

It is the object of the present invention to provide a telautographic system in which alternating currents may be utilized directly for the operation of the system without going to the expense and inconvenience of providing and installing means for converting it into direct current.

In the accompanying drawings—

Figure 1 is a diagrammatic view of so much of a telautographic system of the variable current strength type as is necessary for an understanding of the present invention;

Figure 2 is a vertical elevation of a modification which will be later on referred to;

Figure 3 is a section on the line 3—3 of Figure 1;

Figure 4 is a diagrammatic view illustrating a system for use on long lines or lines where the resistance is high;

Figures 5 and 6 are diagrammatic views illustrating another modified system; and

Figure 7 illustrates another modification hereinafter described.

Referring to Figure 1, it will be understood that the mechanism shown in the lower part thereof is the transmitter, while that shown in the upper part thereof is the distant receiver of a telautographic system, the two instruments being connected by right and left main line circuits (including wires 1, 2) which are traversed by writing currents and which control the lateral or writing movements of the receiving pen. The source of these writing currents is an alternating current generator 3, one terminal of which is grounded by wire 4 at 5, and the other terminal of which is connected by wires 6, 7, with a pair of pivoted bell crank levers 8, 9. The short or contact arms of these levers are provided with spring pressed roller contacts 10, 11, respectively, and the other arms thereof are pivotally connected with a pair of pen-arms 12, 13, respectively, in the converging ends of which is loosely mounted a transmitting tracer 14. Contact rollers 10, 11 engage a pair of rheostats 15, 16 connected with right and left main line wires 1, 2, respectively. It will be understood that as tracer 14 is moved laterally or sideways, as a pen or pencil is moved in ordinary writing, contacts 10, 11, will be moved lengthwise of their respective rheostats 15, 16, so that the resistance in the main lines 1, 2 will be increased or decreased and the currents traversing these lines from generator 3 correspondingly decreased or increased in strength.

Referring now to the receiver, and particularly to the right hand side thereof, it is provided with a laminated iron field magnet 19 (designated 190 on the left hand side), having a core 20 (indicated by dotted lines) enclosed by but out of contact with four polar projections 21, 22, 23, 24 of the magnet, the inner surfaces of said projections being curved and forming a circle concentric with core 20. The left hand side of the receiver is provided with like parts to those on the right hand side of the receiver, which parts are designated by like reference numerals, except as otherwise indicated, as, for example, in the case of the magnets 19, 190.

A metal cup or rotor 25, preferably of aluminum, and pivoted to core 20, surrounds the latter and extends down into the space between it and the polar projections 21, 22,

23, 24, as best shown in Figure 3. This rotor or cup has attached to it one end of a spiral spring 26, the other end of which is attached to magnet 19. The tendency of this spring is to rotate the cup 25 in a clockwise direction.

Magnet 19 is also provided with windings 27, 28 between the polar projections or pole pieces 21, 22 and 23, 24, respectively, and with windings 29, 30 on its yoke. The windings 27, 28, 30 are connected, through wires 31, 32, 33 to form a closed circuit, while winding 29 is connected, through main line wire 1, rheostat 15, roller contact 10, tracer arm 8, and wire 6 with one terminal of alternating current generator 3, and, through wires 34, 35, with ground at 36 and thence to ground at 5, and by wire 4 with the other terminal of said generator. Winding 29 of magnet 190 on the left hand side of the receiver is similarly connected with generator 3 by wire 2, rheostat 16, roller contact 11, tracer arm 9, and wires 7, 6, and with ground at 36 by wires 134, 35.

Cup 25 is provided with a pinion 37 meshing with a pivotally mounted arc-shaped sector 38 to which is fixed one end of a lever 39, the opposite end of which has pivotally connected with it one end of a pen arm 40. In the converging ends of the pen arms 40 is mounted a receiving pen 41.

As the parts are shown in Figure 1, the transmitter tracer 14 is away from its unison position (which is to the left) and as in the act of writing and transmitting to the receiver. Alternating writing currents are therefore traversing the main lines 1, 2 to, the receiver, from generator 3. The effect of these currents in producing the required rotation of rotors or cups 25, so that receiving pen 41 will reproduce the movements and writing of the tracer 14, is as follows:

Selecting, for convenience, the right hand side of the receiver, if the windings 27, 28, 30 be disregarded, and the winding 29 therefore alone be considered, the only effect of the alternating currents traversing right main line 2 is the magnetization of polar projections 21, 22 of like polarity, and the magnetization of polar projections 23, 24 also of like polarity but of opposite polarity to projections 21, 22; the polarities of each such pair of projections being reversed on each reversal of the current traversing the main line 1. The effect of all this, in turn, on cup 25, would be simply the vibration of cup 25, with no definite tendency to rotate and therefore no writing movement of receiving pen 41, corresponding to the writing movements of tracer 14, or otherwise.

The presence and relative arrangement of the windings 27, 28 and 30, however, provide for such rotation of cup 25 and such writing movements of the receiving pen. Considering these windings, in connection with winding 29, it will be obvious that winding 30 serves as the secondary winding of a transformer of which the winding 29 is the primary, and that the alternating currents traversing winding 29 from main line 1 will induce corresponding currents in the winding 30. These induced currents traversing windings 27, 28 (which are included with winding 30 in the closed circuits 31, 32, 33) will magnetize the polar projections 21, 22, 23, 24 of magnet 19, so that the projections of each pair 21, 22 and 23, 24, instead of being of like polarity, will be of opposite polarity, while the diametrically opposite poles 21, 23 and 22, 24 will also be of opposite polarity. Furthermore, the windings 27, 28, 30 are so proportioned and related to the winding 29 that the currents induced in these windings will lag about 80° behind that in the winding 29, so that when the magnetization of magnet 19 is at its maximum, from the action of the current in said winding 29, the magnetizing current in windings 27, 28 is about at its minimum, and vice versa. The result of all this is that the magnetic flux will rise to its greatest density alternately between polar projections 21, 23 and magnet core 20, or between polar projections 22, 24 and core 20, according as the currents in winding 29 are rising or falling in the curve of the current wave. Windings 27, 28, 30 are so connected that the magnetizing action of the currents in windings 27, 28 cause the points of greatest flux density to shift from pole to pole in a counter-clockwise direction. This shifting of the flux around magnet core 20 will induce currents in the rotor or cup 25 which, by re-acting with the shifting flux, will cause cup 25 to rotate in a counter-clockwise direction, increasing the tension of spring 26 (which tends to turn the cup in a clockwise direction) until it balances the torque given to cup 25. As the strength of the current traversing winding 29 is increased the torque of cup 25 will correspondingly increase and the cup will rotate until spring 26 again balances the torque of the cup, and so on.

All of the foregoing description of construction and operation, though directed particularly to the right hand side of the receiver, is of course equally applicable to the left hand side of the receiver.

It will be understood that as the tracer 14 is moved laterally in writing the contact rollers 10, 11, will be moved lengthwise of the rheostats 15, 16 and thus introduce more or less resistance into their respective main lines 1, 2 and windings 29 of field magnets 19, 19^a, the currents traversing these main

lines and windings being increased and decreased according to the extent and direction of movement of tracer 14. These variations in the line currents will result in corresponding variations in the torque of cups 25, which will rotate, in a counter-clockwise direction, to a greater or less extent, dependent upon such variations in the line currents. The cups 25, thus rotated, will, through pinions 36, sectors 37, levers 39, and arms 40, cause receiving pen 41 to move in unison with and reproduce the writing movements of the tracer 14. The movements of the cups 25 and their pinions 36 in the opposite or clockwise direction, are effected by the springs 26.

In this construction excessive vibration of the receiving pen is eliminated for the following reasons:

The splitting of the single phase alternating current from generator 3 into a plurality of phases, by the connection with the main lines of the magnet 19 and its windings, causes the frequency of the current to be doubled with respect to its effect upon the cups 25, thus diminishing the amplitude of the vibration.

The torque of the cups 25 never ceases, but always has a minimum value of 30 or 40% of its maximum value for a given strength of magnetizing current. This greatly diminishes vibrations.

The ratio of gearing between the pinions 36 and their sectors 37 is such as to require a comparatively large amount of vibration of the cups 25 to injuriously affect the motion of the receiving pen 41, the ratio of such gearing being such that there is less angular movement of the receiving pen shaft than of the rotors.

A certain amount of damping effect is produced by the action of induced currents produced in the cups 25, 25^a by their motions.

The combination of these conditions causes the vibration of the receiving pen to be reduced to a degree that is not objectionable. On the contrary, such vibration as does exist is of positive value in diminishing the friction of the receiving pen on its recording surface as well as diminishing the friction of the pen moving parts.

It is to be understood that the present invention is not limited to the specific phase-splitting means shown.

It is also to be understood that the invention is not limited to systems employing rotary field magnets, as shown, but includes other forms of magnets, as, for example, the solenoid form illustrated in Fig. 2. In this two solenoids 45, 46 are provided for each side of the receiver, those shown being for the right hand side. The cores 47, 48 of these solenoids are joined by a yoke 49, to which is attached one end of a cord 50 passing around a sector 51 and connected at its other end with a spring 52. Sector 51 is connected with lever 39 and the latter to pen arm 40. In this construction the vibration due to the alternating currents is diminished by causing the currents traversing one solenoid winding to differ in phase from those in the winding of the other solenoid. The line currents enter at 1, through wire 53, winding of solenoid 46, wire 53^b, wire 56 to ground. A portion of the line current will leave wire 1 and pass through wire 1^b, condenser 55, wire 54, winding of solenoid 45, wires 54^b, 56 to ground.

The effect of the condenser in this current is to advance the phase of the currents traversing the winding of solenoid 45 relatively to those traversing the winding of solenoid 46, thus maintaining a tension at all times upon the yoke 49 and chain 50; variations in the strength of the line currents in accordance with the motions of the transmitting tracer causing variations to the joint pull of the solenoids.

The system shown in Figure 1 is designed for use on what may be termed short lines or lines in which the resistance is low. In Figures 4–6 are shown other systems, which will now be described, adapted for use on longer line, or lines in which the resistance is high. The parts present in these modified systems corresponding to those in Fig. 1 are, for convenience, designated by like reference characters.

In the system illustrated in Fig. 4, it will be noted that the primary windings 29 of the magnets 19, 190, (present in Fig. 1) are omitted and that the system is provided with pen-lifting and paper shifting mechanisms (not present in Fig. 1) which will be described later on. It will also be noted that there are two alternating current generators 60 (terminal 61 of which is grounded by wires 62, 63, at 64) and 65 (terminal 66 of which is grounded by wires 67, 68 and 69) whose functions will be stated later on, and an electrically operated master switch 71 controlling the connection of the transmitter circuits with the receiver circuits and with generator 60, and which is in turn controlled by a tracer-operated or hand-operated switch 72, as hereinafter fully described. This master switch mechanism, which has certain important features of novelty, is not claimed herein but will form the subject matter of a separate application for Letters Patent.

In the closed position (shown) of master switch 71, the right main line circuit from transmitter to receiver consists of wire 68 from ground, at 69, wires 72, 73, 74, rheostat 15, contact roller 10, tracer arm 8, wire 75, one secondary winding 76 of a transformer 77, wire 78, contact plate 79, contact 80, wire 81, pole piece winding 28 of magnet 19, wire

31, pole piece winding 27 of magnet 19, wire 82, secondary winding 83 of a transformer 84, and wires 85, 86, 63 to ground at 64.

In such position of master switch 71 the left main line circuit from transmitter to receiver consists of wire 68 from ground, at 69, wire 87, rheostat 16, contact roller 11, arm 9, wire 88, the other secondary winding 89 of transformer 77, wire 90, contact plate 91, contact 92, wires 93, 94, the winding of a relay 95, wire 96, pole piece winding 28 of magnet 190, wire 31, pole piece winding 27 of said magnet, wire 97, secondary winding 98 of a transformer 99, and wires 86, 63 to ground at 64.

It will be observed that the pole piece windings 28, 27 of magnet 19, and the secondary winding 83 of transformer 84, are in series with the right main line circuit, just described, while the polar windings 28, 27 of magnet 190 and the secondary winding 98 of transformer 99 are in series with the left main line circuit.

The closing of these two main line circuits, through master switch 71, is effected by the tracer-operated switch 72 which, when moved to the right by the tracer 14, or by hand, engages a contact 100 and closes a circuit from the terminal 101 of generator 65 through the upper magnet 102 of said master switch, consisting of wires 103, 104, switch 72, contact 100, wire 105, magnet 102, and wires 106, 73, 72, 67 to terminal 66 of generator 65. The closing of this circuit energizes upper magnet 102 which then attracts its centrally pivoted balanced armature 107 which in turn moves master switch 71 to the position shown. In this position contact plate 79 is engaged with contact 80, thus closing the right main line circuit, and contact plate 91 is engaged with contact 92, thus closing the left main line circuit.

Master switch 71 is provided with a third contact plate 108 which, in this position of the switch engages a contact 109 and thereby closes a circuit (hereinafter fully described) including the primary coil 110 of transformer 77 and controlled by transmitter platen 111; the function of this circuit being to effect the raising and lowering of the receiving pen 41 as the transmitter tracer is raised and lowered.

The engagement of switch 72 with contact 100 and the resulting energization of upper magnet 102 is only temporary, but the master switch 71 is retained in the raised or circuit closing position shown by reason of the fact that the armature 107 is balanced and remains in the position to which it is moved by upper magnet 102. Switch 71 is also retained in its raised position by the frictional engagement therewith of armature 107 which remains in the position to which it has been moved by upper magnet 102 until moved from that position, after a transmitting operation, by lower magnet 112. The armature, being balanced, will remain in the latter position until again moved by upper magnet 102. The energization of the latter for that purpose is effected from generator 65 by a circuit controlled by tracer-operated switch 72 and consisting of wires 103, 104, from terminal 101 of generator 65, switch 72, contact 113 (engaged by switch 72 when the latter is moved to the left), wire 114, winding of magnet 112 and wires 106, 73, 72, 67, to the terminal 66 of generator 65. The closing of this circuit energizes lower magnet 112 which, attracting armature 107, will swing it in the opposite direction to that shown and thereby disengage its upper end from master switch 71 which will then drop from the position shown and disengage its contact plates 79, 91 from contacts 80, 92, respectively, and thus open the right and left main line circuits and disconnect the transmitter from the receiver. Contact plate 108 will also then be disengaged from contact 109.

The source of energy for the writing currents which are to traverse the right and left main lines is the alternating current generator 60 at the receiving instrument. The circuits for this purpose are as follows: wire 62 from terminal 61 of generator 60, wires 115, 116, follow-up contact plate 117 of relay 95, contact 118, wire 119 and from wire 119 (for the right hand side of the receiver) wires 120, 121, 125, main winding 29 of magnet 19, wire 122, primary winding 123 of transformer 84, and wires 124, 125, 126, to terminal 127 of generator 60, and from wire 119 (for the left hand side of the receiver) wire 128, main winding 29 of magnet 190, wire 129, primary winding 130 of transformer 99, and wires 125, 126, to terminal 127 of generator 60. Contact plate 117 and armature 134 are insulated from each other as shown at 300 so that when these parts are in the position shown in Fig. 4 they are not electrically connected with each other. When, however, the armature and follow up contact plate 17 are in their lowermost position they are electrically connected by contacts 301, 302.

The closing of these circuits is controlled from the transmitter through a relay 131 at the receiver in the following manner: This relay is in a branch circuit from right main line wire 81 consisting of wire 132, winding of relay 131, wire 133, armature 134 of relay 95, follow-up contact plate 117 thereof (when said relay is deenergized and said contact is in its lowermost position) and wires 116, 115, 63 to ground at 64. This branch circuit is closed by the closing of the main line circuit and is connected with the terminal 101 of generator 66 by the movement of tracer arm 8 to the right into en-

gagement with a stationary contact 135. Such movement and engagement take place when (as before described) the tracer 14 is moved to the left and moves the switch 72 into engagement with contact 100 to raise master switch 71 and thus connect the writing current transmitter circuits with the receiver circuits. When tracer arm 8 so engages contact 135 the right main line is connected, for the moment, with terminal 101 of generator 65 by wires 103, 136, contact plate 108, contact 109, wire 137, resistance 138, wire 139, contact 135, tracer arm 8, wire 75, secondary winding 76 of transformer 77, wire 78, contact plate 79, contact 80, wire 81, pole piece winding 28 of magnet 19, wire 31, pole piece winding 27, wire 82, secondary winding 83 of transformer 84, and wires 85, 86, 63 to ground at 64. (The left main line is grounded at 64 and 69 and therefore not electrically connected with generator 65). Part of the current then traversing the right main line circuit will pass over the branch circuit 132, etc. to ground at 64, before described, and energize relay 131 which will then attract its armature 140 and close the following circuits, at the receiver, from terminal 61 of generator 60 through main windings 29 of magnets 19, 190 and primary transformer windings 123, 130, namely: wires 62, 115, 141, armature 140, contact 142, wire 143, wire 144, and from wire 144 (for the right hand side of the receiver) wire 125, etc. through main winding 29 of magnet 19 and primary winding 123 to terminal 127, and from wire 144 (for the left hand side of the receiver), wires 121, 120, 128, etc. through main winding 29 of magnet 190 and primary transformer coil 130 to terminal 127.

The closing of these circuits by relay 131 is merely momentary and is for the purpose of connecting said circuits for a writing operation with generator 60. While the closure lasts currents traverse these circuits and the primary transformer windings 123, 130 and induce currents in the secondary transformer windings 83, 98, and the right and left main lines from the transmitter to the receiver. The first effect of such currents traversing the left main line is to energize relay 95 which will then attract its armature 134 and separate it from its follow-up contact plate 117. Their separation breaks the branch circuit just described through relay 131 which is then deenergized and releases its armature 140. Follow-up contact 117, following the armature 134, will move upwardly into engagement with contact 118 and thus close the two circuits, hereinbefore described, including wires 119, 120, 121, 122 and 119, 128, respectively, through main windings 29 of magnets 19, 190 and primary transformer windings 123, 130. These circuits remain closed while the right and left main line circuits are closed by master switch 71 because, during such closure of the left line, the induced currents traversing it will maintain the contact plate 117 in engagement with contact 118.

As before indicated, the connection of the right main line circuit with generator 66 is temporary, continuing only while tracer arm 8 remains in engagement with contact 135, such engagement being broken as soon as the tracer 14 is moved, for writing, away from switch 72. Continued connection of the left main line with generator 65, after relay 131 has been energized to close the circuits from generator 60 through magnet windings 29 and primary transformers 123, 130, is not only unnecessary but undesirable during a writing operation, as that generator might be out of phase with generator 60.

From the foregoing it will be understood that polar piece windings 27, 28 of magnet 19 and the secondary transformer winding 83 and the pole piece windings 27, 28 of magnet 190 and the secondary transformer winding 98, are connected in series with the right and left main lines, respectively, and that the main magnet winding 29 of magnet 19 and primary transformer winding 123, and the main magnet winding 29 of magnet 190 and primary transformer winding 130, are connected in series with the circuits from generator 60 which are closed by relay 131. As a result of this, currents will traverse the latter circuits through main magnet windings 29, and primary transformer windings 123, 130, and induced currents from the secondary transformer windings 83, 98, will traverse the right and left main lines, and the pole piece windings 27, 28 of magnets 190, respectively. As the latter currents differ in phase from those traversing the main magnet windings 29, the fields of magnets 19, 190 will be caused to rotate in opposition to the springs 26, thus creating a rotational torque in the rotors or cups 25 of these fields. As the transmitter tracer 14 is moved in writing and the contact rollers 10, 11 are thereby moved lengthwise of rheostats 15, 16, the resistance of the right and left main line circuits will be varied and corresponding variations will result in the strength of the currents traversing these lines and consequently in the torque of the rotors, which, opposing the force of their springs 26, will cause the receiving pen 41 to move laterally or sidewise in unison with the lateral or sidewise movements of the transmitting tracer.

For effecting the movements of the receiving pen 41 to and from its writing surface as the transmitting tracer 14 is so moved relatively to its writing platen 111, the receiver is provided with the usual pen-lifting magnet 145 having a pen rest 146 rest-

ing upon the rocking armature 147 of said magnet. The energization and deenergization of magnet 145 are controlled from the transmitter by the pivotally mounted writing platen 111 through a circuit consisting of wire 103 from terminal 101 of generator 65, wire 136, contact plate 108, contact 109, wires 137, 148, primarly winding 110 of transformer 77, wire 150, stationary contact 151, platen contact 152, platen 111, wire 153, and thence (according to the position of the armature 154 of an interrupter magnet 155 which has a definite pitch different from the frequency of the writing currents traversing the main lines) wire 156, winding of magnet 157 of said interrupter, wire 158, contact 159, armature 154 and wires 160, 72, 67 to terminal 66 of generator 65, or (from wire 153) wire 161, winding of magnet 162 of interrupter 155, wire 163, contact 164, armature 154, and wires 160, 72, 67 to terminal 66 of generator 65.

In the upper position of platen 111 contacts 151, 152 are engaged and this circuit is closed. When platen 111 is depressed by downward pressure thereon of tracer 114, contacts 151, 152 are disengaged and this circuit is opened. When the circuit is closed, magnet 157 will be energized and attract the armature 154, moving it from contact 159 to contact 164, thus breaking the circuit through magnet 157 and closing it through magnet 162, which will then move armature 154 away from contact 164 and again to contact 159, and so on, the two circuits being constantly made and broken. The effect of this is to keep the armature 154 in a constant state of vibration and through primary winding 110 of transformer 77 produce corresponding vibrations in the secondary windings 76, 89 of said transformer which, it will be remembered, are in the right and left line circuits to the receiver. These induced vibratory currents are utilized to control the energization of pen-lifting magnet 145 through a vibrating relay 165, as will presently appear.

Vibrating relay 165 is bridged across the right and left main line circuits by a circuit consisting of wire 166 from right line wire 81, winding of relay 165, wire 167, condenser 168, and wire 169 to left main line wire 93; this circuit providing a path, through relay 165, for the vibrating currents traversing the main lines from generator 66, when platen 111 is in its upper position. This relay, through its armature 170, controls the condition of a circuit which includes pen-lifting magnet 145 and therefore the condition of the latter. This circuit consists of wire 62 from terminal 81 of generator 60, wires 115, 116, contact plate 117 of relay 95, contact 118, wires 119, 120, 171, armature 170, spring pressed follow-up contact plate 172, wire 173, windings of pen-lifting magnets 145, and wires 174, 126 to the other terminal (127) of generator 60.

The armature 170 of relay 165 has a normal pitch approximately that of the vibratory pen-lifting currents traversing the main line circuits. Consequently it is extremely sensitive to these currents and under their influence vibrates sufficiently to throw follow-up contact 172 out of contact with it, thus effectively opening the circuit through pen-lifting magnets 145. While platen 111 is relieved from downward pressure by tracer 14 and is therefore in its upper position with contacts 151, 152 engaged (the right an left main lines being closed by master switch 71), armature 154 of interrupter 155 is vibrated so as to produce in the right and left main lines the induced vibrating currents before referred to. These currents, traversing the winding of relay 165 (through the circuits 166, 167, 168, 169) will cause its armature 170 to vibrate rapidly and thus rapidly make and break the circuit just described through pen-lifting magnets 145. The effect of this is to so weaken the current traversing said pen-lifting circuit that the pen-lifting magnets 145 are practically deenergized, so far as any effect on armature 147 is concerned, said armature and pen rest 146 therefore remaining in their raised position and supporting receiving pen 41 in its raised position away from its writing surface, which is the position at the time of tracer 14 relatively to platen 111.

When tracer 14 is lowered to writing position and platen 111 is depressed thereby, contacts 151, 152 disengaged and the circuit through interrupter 155 is broken. There are then no vibrations traversing relay 165 from interrupter 155. The follow-up contact plate 172, in such case, remains steadily in contact with armature 170, with the result that the pen-lifting magnets 145 will be energized from generator 60 sufficiently to rock armature 147 and lower the receiving pen 41 to its writing surface.

The system shown in Fig. 4 is also equipped with paper shifting mechanisms including paper shifting magnets 175 at the receiver, the armature 176 of which carries paper gripping means 177. These magnets are energized by currents from generator 60 through a circuit consisting of wire 126 from terminal 127 of generator 60, wires 125, 179, windings of magnets 175, wires 180, 144, 121, 119, contact 118, contact plate 117, and wires 116, 115, 62, to terminal 61 of generator 60. This circuit is closed, and magnets 175 are energized to shift the paper strip one line space, when as before described (master switch 71 being in the position shown) tracer 14 is moved to unison at the left, and tracer arm 8 is therefore moved to the right into engagement

with contact 135. This temporarily closes the circuit, heretofore described, from generator 65 over the right main line and from the latter through relay 131, which as before described is in a branch circuit 132 et seq. from the right main line to ground at 64. Relay 131 then attracting its armature, closes the circuits, heretofore described, from generator 60 including the main windings 29, of magnets 19, 190 and the primary windings 123, 130 of transformers 84, 99. Currents are induced thereby in the secondary windings 83, 98 of transformers 84, 99, and therefore in the right and left main lines. Those in the left main line traversing the winding of relay 95 (which is included in the left line) will energize that relay and the latter will attract its armature 134 and disengage it from follow-up contact 117, thus opening the circuit just referred to through relay 131 and closing the circuit above described through paper shifting magnets 175, which will then be traversed by current from generator 60.

When master switch 71 is moved from the position shown, by engaging tracer-operated switch 72 with contact 113, and thereby causing magnet 112 of said master switch to be energized, the main line circuits are opened and relay 95 deenergized, thus opening the circuit through paper-shifting magnets 175, the armature 176 and paper gripping means of which then move toward the receiver writing field to take a fresh grip upon the paper for the next shift.

All that is necessary, therefore, to shift the paper at the receiver, is to move master switch 71 to the position shown, by engaging tracer 14 with switch 72 and moving the latter into engagement with contact 100, tracer arm 8 simultaneously engaging contact 135 and connecting the right main line with generator 65. This will shift the paper at the receiver a one-line space. If it be desired to shift it several line spaces, switch 72 is shifted, as many times as desired, into engagement with contacts 100, 113.

As indicated in the drawing, the normal position of this switch 72 is midway of the contacts 100, 113, its engagement with each of which is only momentary but sufficient to set the master switch 71 to the desired position for opening or closing the main lines to the receiver.

In the system shown in Figs. 5 and 6, there are two complete stations or sets of instruments, that is to say, a transmitter and a receiver for each station, the two stations or sets being designated as A and B, for convenience of reference. Corresponding parts in the two stations bear like reference numerals, those in Fig. 6, or station B, being followed by "×" for convenience of reference. The paper shifting magnets and the circuits therefor and for the penlifting magnets, shown in Fig. 4, are omitted, as their illustration here would be unnecessary repetition. The transformers 84, 99 of Fig. 4 are also omitted here to provide a simplified system for use on telautographic lines where the resistance is moderate, as is usually the case. In other words, on such lines the use of transformers to split the phases of the alternating current is unnecessary, whereas on lines of high resistance they are of decided advantage, the secondary windings of the transformers being capable of being wound to give a much higher voltage than that of the primary windings.

In the system of Figs. 5 and 6 there are a master switch 71, generally like that of Fig. 4, and performing the same functions, and also a tracer-operated switch 72 controlling the master switch and the circuits opened and closed thereby, and the transmitter of station A is shown as connected with the receiver of station B and as writing, with the tracer 14 of the former and the receiving pen 41 of the latter away from the unison position and moved some distance over their respective fields. The transmitter of station B and receiver of station A being disconnected, the tracer 14 of the former and the receiving pen 41 of the latter are shown at unison, to the left. The transmitter of A and receiver of B will be selected for detailed description, the description given, however, being equally applicable to the other instruments.

In this system there are also present the relay 95 (or $95^{\times}$), with its armature 134 (or $134^{\times}$) and follow-up contact 117 (or $117^{\times}$) and the relay 131 (or $131^{\times}$) of Fig. 4; these relays and their associated parts being controlled and performing the same functions substantially as in Fig. 4.

The source of energy for the writing currents, when station A is transmitting to station B, is an alternating current generator $200^{\times}$ at the distant station B, the generator 200 at station A, in such case, serving the function of connecting the circuits at its transmitter with those of the receiver at station B and with the generator $200^{\times}$ at the latter station for such transmitting operation.

The normal or non-transmitting position of switch 71 is that in which switch $71^{\times}$ is shown in Fig. 6, which is its receiving position. Switch 71 is moved from such position to the position in which it is shown in Fig. 5 by upper magnet 102 of said switch, which is energized for that purpose by current from generator 200 over a circuit controlled by switch 72 and closed by the latter when moved toward the right, as shown in Fig. 5. The circuit so closed consists of terminal 201 of generator 200, wire 202, winding of upper magnet 102, and wire 226, contacts 225, 212, and switch 72 and

wire 235 to the other terminal of generator 200. When this circuit is closed magnet 102 will move its armature 107 to the position shown in Fig. 5 and thus connect the right and left main line circuits from transmitter of station A with those to the receiver of station B. The engagement of contacts 212 and 225 for this purpose is only momentary, but the right and left main lines nevertheless remain connected as armature 107 remains in the position shown, after such engagement is broken, by frictional engagement with spring contact plate 79 of the master switch 71. To disconnect the main line circuits, switch 72 is moved from its normal or mid-position (shown) to the left into engagement with another contact 227. This closes a circuit as follows through the lower magnet 112 of master switch 71; terminal 201 of generator 200, wire 202, winding of lower magnet 112, and wire 228, contact 227, switch 72, contact 212 and wire 213 to ground at 214. Lower magnet 112 then rocks its armature 107 from the position shown in Fig. 5 to the position in which the armature 107^{x} is shown in Fig. 6, contact plates 79, 91 being thereby disengaged from contacts 80 and 92, respectively, and opening the right and left main line circuits to the receiver of station B.

Simultaneously with the engagement of contacts 212, 225 (effected by the tracer 14, which is moved to the extreme left for the purpose) tracer arm 8 will engage a contact 135 and close a circuit as follows, over the right main line to the receiver of station B: (Fig. 5), terminal 201 of generator 200, wire 202, contact plate 108 and contact 109 of master switch 71, wire 237, resistance 238, wire 239, contact 135, tracer arm 8, wire 210, contact 80 and contact plate 79 of master switch 71, right main line wire 209 and, (Fig. 6), right main line wire 209^{x}, contact plate 79^{x} and contact plate 208^{x} of master switch 71^{x}, wires 207^{x}, 240^{x}, winding of relay 131^{x}, wire 241^{x}, armature 134^{x} and follow-up contact 117^{x} of relay 95^{x}, wires 204^{x}, 205^{x}, 230^{x}, main winding up contact 117^{x} of relay 95^{x}, wires 204^{x}, 205^{x}, 230^{x}, main windings of magnets 29^{x}, wires 232^{x}, 233^{x}, 234^{x}, 235^{x}, switch 72^{x}, contact 212^{x}, and wire 213^{x} to ground at 214^{b}.

The first effect of the closing of this circuit is to energize relay 131^{x} which will then attract its armature 140^{x} and close the following circuit: terminal 201^{x} of generator 200^{x}, wires 202^{x}, 242^{x}, contact 142^{x}, armature 140^{x} of relay 131^{x}, wires 243^{x}, 205^{x}, 214^{x}, pole piece winding 27^{x} of magnet 190^{x}, wire 31^{x}, pole piece winding 28^{x} of said magnet, wire 215^{x}, winding of relay 95^{x}, wire 216^{x}, contact 217^{x} and contact plate 91^{x} of master switch 71^{x}, left main line wire 219^{x} and (Fig. 5), left main line wire 219, contact plate 91 and contact 92 of master switch 71, wire 220, tracer arm 9, roller contact 11, rheostat 16, and wires 221, 211, switch 72, contact 212 and wire 213 to ground at 214^{a}.

The current traversing this circuit will cause relay 95^{x} to attract its armature 134^{x} and move it out of engagement with follow-up contact 117^{x} and the latter into engagement with stationary contact 118^{x}. This breaks the circuit through relay 131^{x} and closes the following main line circuits through the pole piece windings 27^{x}, 28^{x} of magnets 19^{x}, 190^{x}:

Right line (Fig. 6).—Terminal 201^{x} of distant generator 200^{x}, wires 202^{x}, 203^{x}, contact 118^{x}, follow-up contact 117^{x} of relay 95^{x}, wires 204^{x}, 205^{x}, pole piece winding 27^{x} of magnet 19^{x}, wire 31^{x}, pole piece winding 28^{x} of said magnet, wires 206^{x}, 207^{x}, contact 208^{x} and contact plate 79^{x} of master switch 71^{x}, wire 209^{x}, and (Fig. 5) wire 209, contact plate 79, contact 80, wire 210, tracer arm 8, contact roller 10, rheostat 15, wire 211, switch 72 and contact 212 and wire 213 to ground at 214^{a}.

Left line (Fig. 6).—Terminal 201^{x} of distant generator 200^{x}, wires 202^{x}, 203^{x}, contact 118^{x}, follow-up contact 117^{x} of relay 95^{x}, wires 204^{x}, 205^{x}, 214^{x}, pole piece winding 27^{x} of magnet 190^{x}, wire 31^{x}, pole piece winding 28^{x}, wire 215^{x}, winding of relay 95^{x}, wire 216^{x}, contact 217^{x} and contact plate 91^{x} of master switch 71^{x}, wire 219^{x} and (Fig. 5) wire 219, contact plate 91 and contact 92 of master switch 71, wire 220, tracer arm 9, roller contact 11, rheostat 16, wires 221, 211, switch 72, contact 212 and wire 213 to ground at 214^{a}.

Simultaneously there are also established the following circuits at the receiver through the main windings of magnets 29^{x}: wire 202^{x} from terminal 201^{x} of distant generator 200^{x}; wire 203^{x}, contact 118^{x}, contact plate 117^{x}, wires 204^{x}, 205^{x}, wires 230^{x}, 231^{x} to main windings, magnets 29^{x}, wires 232^{x}, 233^{x}, thence to wire 234^{x} and wire 235^{x}, switch 72^{x}, contact plate 212^{x} and wire 213^{x} to ground at 214^{b}.

The two sets of circuits thus established, one set (the right and left main lines) including the pole piece windings 27^{x}, 28^{x} of magnets 19^{x}, 190^{x} and the other set (the receiver circuits) including the main windings 29^{x} of said magnets are the writing circuits, and the source of electric energy for both is the alternating current generator 200^{x}, generator 200 being disconnected from the right main line by the movement of the tracer arm 8 out of engagement with contact 135.

Current is now flowing through the main windings 29^{x} and the pole piece windings 27^{x}, 28^{x} of both field magnets 19^{x}, 190^{x}, from generator 200^{x}, and as the tracer 14 of sta-

tion A is moved laterally over its writing field or platen, and as the roller contacts 10, 11 are moved by it longitudinally of rheostats 15, 16, more or less resistance is introduced into or cut out of the right and left main line circuits, thus causing variations in the strength of the main line currents in accordance with the direction and extent of movement of the tracer. The pole piece and main windings 27^x, 28^x, 29^x of the field magnets 19^x, 190^x are so proportioned and arranged relatively to each other that the self induction of the pole piece windings will be much less than that of the main windings 29^x. It follows that the main line currents will differ from those traversing the main windings, and, as a result, the magnetic fields of magnets 19^x, 190^x will rotate and establish a torque in the rotors or cups 25^x, this torque varying as the strength of the main line currents vary in accordance with the direction and extent of movement of tracer 14. The cups 25 thus rotated in one direction by this torque and in the other by their springs 26 will, through the sectors 38 and pen arms 39, 40, move receiving pen 41 in the same direction and to the same extent as tracer 14 and thereby cause it to reproduce the writing movements and writing of the latter.

It is to be understood that the present invention relates broadly to the utilization of currents differing in phase for the operation of telautographic systems and that therefore it includes systems in which, unlike those shown, the currents utilized of different phase are derived from the source of current supply as shown, for example, in Fig. 7.

In this figure of the drawing only the left hand side of a telautographic system or instrument is shown, illustration of the right hand side being unnecessary, as the parts thereof, as to construction and arrangement, are duplicates of those on the left hand side. The two phase generator 250 shown, is of course common to the two sides of the instrument. Instead of one rheostat, as in the preceding figures, the left hand side of the instrument is provided with two rheostats 15^a, 15^b which are engaged by contact rollers 11^a, 11^b, respectively, carried by arm 9. The two rheostats are connected by wires 251, 252, respectively, with the brushes 253, 254, of generator 250 and those portions of arm 9 with which roller contacts 11^a, 11^b are connected (and which portions are suitably insulated from each other) are connected with main line wires 255, 256 leading to the receiver. At the receiver there is an electromagnet 257 having two pairs of windings 258, 259 and 260, 261, line wire 255 being connected with winding 258 and line wire 256 with winding 260. Windings 258, 259 are connected by wire 262, and windings 260, 261 by wire 263. Windings 259 and 261 of the two pairs are connected by wires 264, 265, 266 with ground at 267.

From this construction and arrangement of parts it results that currents of different phase from generator 250 will traverse main lines 255, 256, respectively, and the two pairs of windings 258, 259 and 260, 261, respectively, at the receiver and cause the cup or rotor 25 to rotate and thus, through pen lever and arms 39, 40 move the receiving pen (not shown) laterally or sidewise, as in ordinary writing. Such rotation of cup 25 is in a counter-clockwise direction, its rotation in a clockwise direction being effected by spring 26, as before. The degree of rotation of cup 25 is controlled by the transmitting tracer (not shown) which, as it is moved in writing, moves the roller contacts 11^a, 11^b lengthwise of the rheostats 15^a, 15^b and by thus varying the resistance in the circuits to the receiver traversed by the currents from generator 250, varies the strength of said currents.

What I claim is:

1. In a telautographic system, the combination, with a receiving pen, a pair of movable armature devices for controlling the pen, and connections between said armature devices and the receiving pen, of a polyphase field magnet for each movable armature, yielding means tending to counteract the action of each field on its respective armature, means for supplying polyphase currents of substantially constant phase difference to the polyphase field magnets, and means for varying the strength of said polyphase currents.

2. In a telautographic system, the combination, with a receiving pen, a pair of movable armature devices for controlling the pen, and connections between said armature devices and the receiving pen, of a polyphase field magnet for each movable armature, yielding means tending to counteract the action of each field in its respective armature, means for supplying polyphase currents of substantially constant phase difference to the polyphase field magnets, a transmitting tracer, and a plurality of resistance rheostats controlled by the tracer and arranged to vary the strength of the currents supplied to the polyphase field magnets of the receiver.

3. In a telautographic system, the combination, with a receiving pen, a movable armature and means for transmitting motion from said armature to the pen, of a polyphase field magnet for said armature, means for generating a single phase alternating current, a transmitting tracer, means controlled by said tracer for varying the strength of said single phase current, phase-splitting means for producing polyphase currents from said single phase current after

its strength has been varied, and circuits including the generator, the strength varying means, the phase-splitting means and the polyphase field magnet.

4. In a telautographic system, the combination, with an electric circuit comprising two parallel branches constituting main lines from the transmitter station to the receiver station, of a generator of single phase alternating currents arranged to energize said circuit, a transmitting tracer, means in each parallel branch for varying the strength of the single phase current, said means being controlled by the tracer, phase-splitting means for each parallel branch whereby polyphase currents are developed from the single phase current in its branch after said current has passed the strength varying means, and a receiver-pen controlling device for each parallel branch, each controlling device being actuated by the polyphase currents developed from its respective parallel branch.

5. In a telautographic system of the current strength type, the combination with the receiving pen, of magnetic devices controlling its writing movements and in turn dependent for their operation upon and controlled by currents differing in phase, a magnet connected with a main line from the transmitter to the receiver controlling the movements of the receiving pen to and from its writing surface, and means controlled by the transmitting tracer for producing vibrations in the writing currents traversing said main line and magnet different from the normal vibrations in said currents to move the pen in one of these directions.

6. In a telautographic system of the current strength type, the combination with the receiving pen, of suitable electro-magnetic fields including coacting movable members controlling the writing movements of the pen, each of said fields having a plurality of groups of windings and circuits controlling its movable member and so arranged that the currents traversing one group will lag behind those traversing another, a magnet in a main line from the transmitter to the receiver controlling the movements of the receiving pen to and from its writing surface, and means controlled by the transmitting tracer for producing vibrations in the writing currents traversing said main line and magnet different from the normal vibrations in said currents to move the pen in one of these directions.

7. In a telautographic system of the current strength type, the combination with the receiving pen, of suitable electro-magnetic fields including coacting rotors controlling the writing movements of the pen, each of said fields having a plurality of groups of windings and circuits controlling its rotor and the said groups being so arranged that the currents traversing one will lag behind those traversing another, a magnet in a main line from the transmitter to the receiver controlling the movements of the receiving pen to and from its writing surface, and means controlled by the transmitting tracer for producing vibrations in the writing currents traversing said main line and magnet different from the normal vibrations in said currents to move the pen in one of these directions.

8. In a telautographic system of the current strength type, the combination with the receiving pen, of magnetic devices controlling its writing movements and in turn dependent for their operation upon and controlled by currents differing in phase, means controlled by the transmitting tracer for varying the strength of such currents, a magnet in a main line from the transmitter to the receiver controlling the movements of the receiving pen to and from its writing surface, and means controlled by the transmitting tracer for producing vibrations in the writing currents traversing said main line and magnet different from the normal vibrations in said currents to move the pen in one of these directions.

9. In a telautographic system of the current strength type, the combination with the receiving pen, of suitable electro-magnetic fields including coacting movable members controlling the writing movements of the pen, each of said fields having a plurality of groups of windings and circuits controlling its movable member and so arranged that the currents traversing one group will lag behind those traversing another, means controlled by the transmitting tracer for varying the strength of such currents, a magnet in a main line from the transmitter to the receiver controlling the movements of the receiving pen to and from its writing surface, and means controlled by the transmitting tracer for producing vibrations in the writing currents traversing said main line and magnet different from the normal vibrations in said currents to move the pen in one of these directions.

10. In a telautographic system of the current strength type, the combination with the receiving pen, of suitable electro-magnetic fields including coacting rotors controlling the writing movements of the pen, each of said fields having a plurality of groups of windings and circuits controlling its rotor and the said groups being so arranged that the currents traversing one will lag behind those traversing another, means controlled by the transmitting tracer for varying the strength of such currents, a magnet in a main line from the transmitter to the receiver controlling the movements of the receiving pen to and from its writing surface, and means controlled by the transmitting

tracer for producing vibrations in the writing currents traversing said main line and magnet different from the normal vibrations in said currents to move the pen in one of these directions.

11. In a telautographic system of the variable current strength type, the combination of a source of alternating current energy, two main lines provided with means controlled by the transmitting tracer for varying their resistance in accordance with the extent and direction of the tracer's movements, a suitable magnetic field including two rotors and inductively coacting main and pole piece windings for effecting their rotation in one direction, the windings of one kind being included in the main lines and the two kinds of windings being so relatively proportioned and arranged that those of one kind will lag behind and have less induction than the other, connections between the rotors and the receiving pen for effecting the movement of the latter in accordance with the tracer's movements, and means controlling the connection of the main lines with the source of energy.

12. In a telautographic system of the variable current strength type, the combination of a source of alternating current energy, two main lines provided with means controlled by the transmitting tracer for varying their resistance in accordance with the extent and direction of the tracer's movements, a suitable magnetic field including two rotors and inductively coacting main and pole piece windings for effecting their rotation in one direction, the windings of one kind being included in the main lines and the two kinds of windings being so relatively proportioned and arranged that those of one kind will lag behind and have less induction than the other, connections between the rotors and the receiving pen for effecting the movement of the latter in accordance with the tracer's movements, springs opposing the force of the rotors, and means controlling the connection of the main lines with the source of energy.

13. In a telautographic system of the variable current strength type, the combination with the receiving pen and its shaft, of suitable electro-magnetic fields including rotors geared to said shaft and controlling the writing movements of the pen and in turn dependent for their operation upon and controlled by currents having a substantially constant difference in phase, the ratio of gearing between the rotors and pen shaft being such that the angular movement of the latter is less than that of the former, the extent of movement of the receiving pen being dependent upon and in accordance with the strength of the actuating currents.

14. In a telautographic system, the combination, with an electric circuit comprising two parallel branches constituting main lines from the transmitter station to the receiver station, of a single phase alternating current generator arranged to energize said circuit, a pair of tracer-controlled rheostats arranged one in each parallel branch of said electric circuit, to produce variations of strength of current in each main line predetermined by the position of the tracer, and a receiver having a pair of pen-moving arms, a pen moved thereby, means at the receiver for developing from each current in each parallel branch a corresponding current out of phase with its respective parallel branch current, and means for utilizing conjointly the current in each branch and its corresponding out-of-phase current to move its corresponding pen moving arm.

In testimony whereof, I have hereunto set my hand.

GEORGE S. TIFFANY.