(No Model.) 3 Sheets—Sheet 1.

S. D. FIELD.

MULTIPLE TELEGRAPHY.

No. 353,128. Patented Nov. 23, 1886.

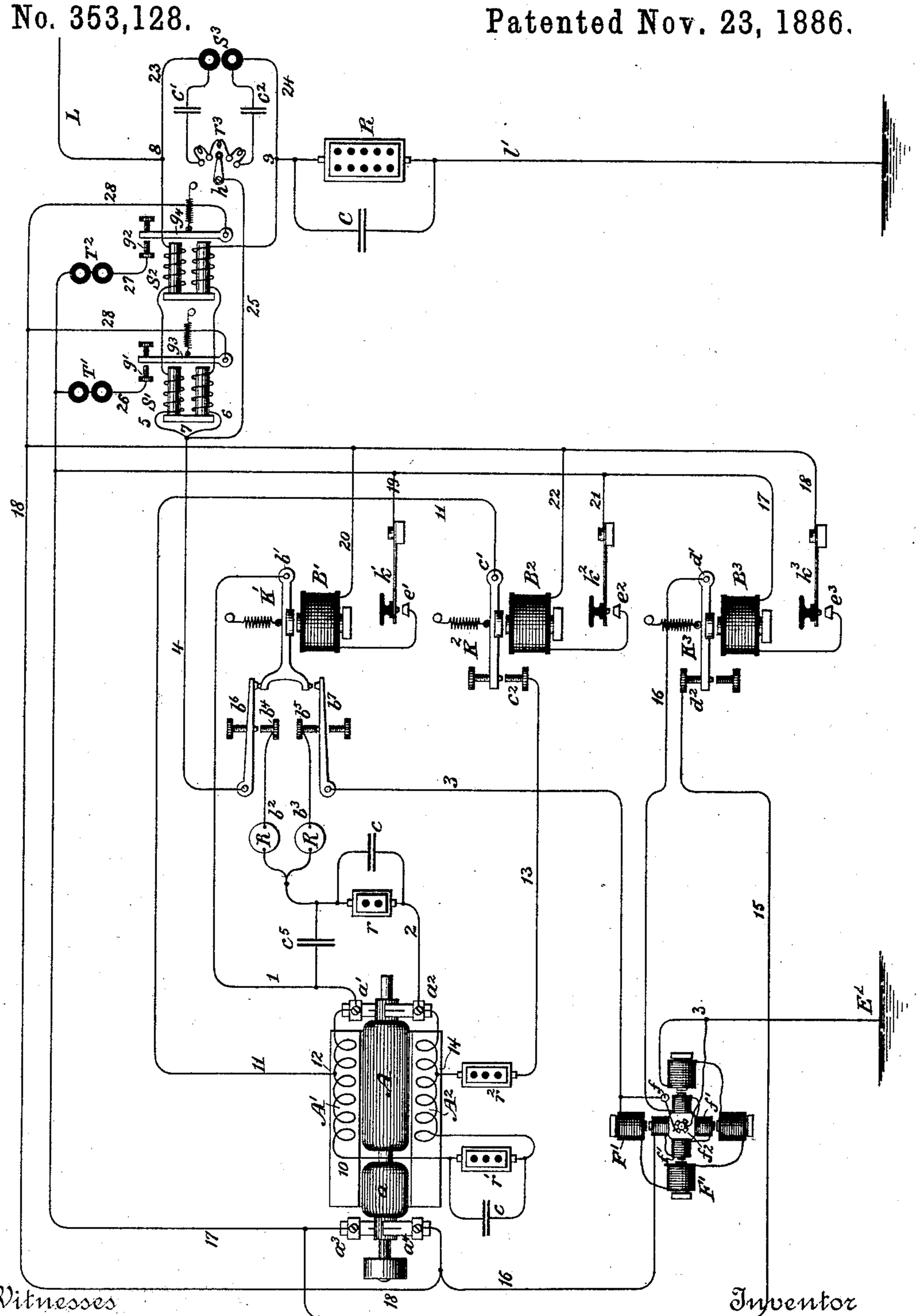

Fig. 1.

Witnesses

Geo W Breck.

Carrie E. Ashley

Inventor

Stephen D. Field,

By his Attorneys

Pope & Edgecomb

(No Model.) 3 Sheets—Sheet 2.

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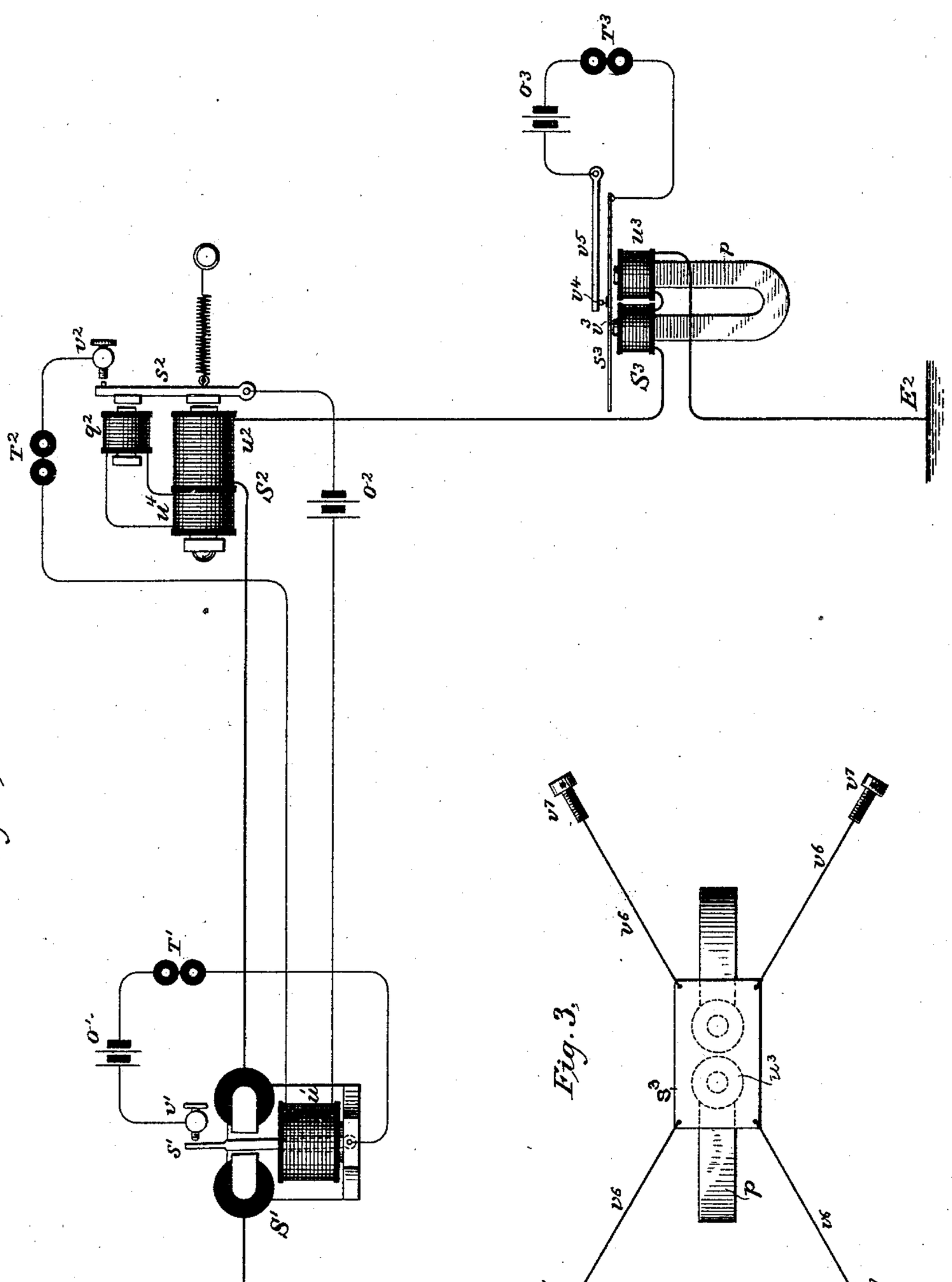

Fig. 2,

Fig. 3,

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Geo. W. Breck.

Carrie E. Ashley

Inventor

Stephen D. Field.

By his Attorneys

Pope & Edgecomb

(No Model.)

3 Sheets—Sheet 3.

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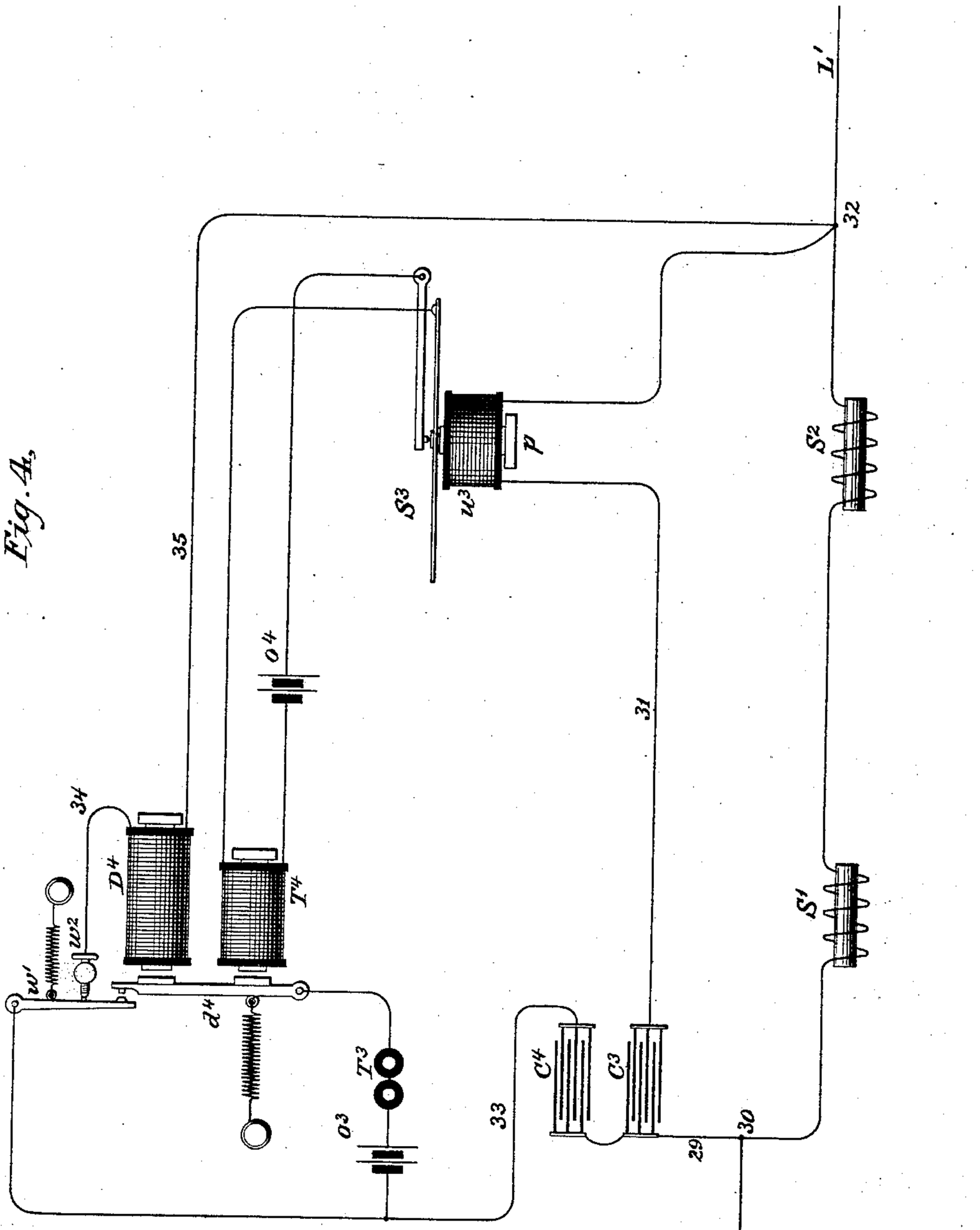
Fig. 4.



Witnesses

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Carrie E. Ashley

By his Attorneys

Inventor

Stephen D. Field,

Pope & Edgecomb

UNITED STATES PATENT OFFICE.

STEPHEN D. FIELD, OF YONKERS, NEW YORK.

MULTIPLE TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 353,128, dated November 23, 1886.

Application filed July 31, 1886. Serial No. 209,609. (No model.)

To all whom it may concern:

Be it known that I, STEPHEN D. FIELD, a citizen of the United States, residing in Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Multiple Telegraphy, of which the following is a specification.

The invention relates to the class of telegraphic systems in which two or more messages are sent simultaneously in the same direction over a single main line. In operating telegraph systems of this character much difficulty is experienced in avoiding the production of false signals by reason of sudden changes in the electrical condition of the main conductor, which occur under certain conditions during the operation of the several transmitters. The object of this invention is, primarily, to avoid all disturbing effects upon the transmission of signals due to the static charge and discharge, and to the varying currents upon the line, and also to provide an economical system of telegraphy.

In carrying out the invention it is preferred to employ a generator capable of producing an approximately-constant current, the direction of which may be reversed, and the strength of which may be varied by independently-operated transmitters. Usually a suitable transmitter for sending harmonic impulses to the line is also employed. The corresponding receiving-instruments are respectively constructed to respond to reversals of the current, to variations in its strength, and to harmonic or vibratory impulses.

The details of the invention will be described in connection with the accompanying drawings, in which—

Figure 1 is a diagram showing the general organization of the apparatus at one terminal, while Fig. 2 illustrates a special organization of the receiving apparatus. Figs. 3 and 4 illustrate modifications in the construction of the harmonic or vibrating receiving-instrument and circuits therefor.

Referring to the figures, A represents an electric generator of any suitable character, preferably a shunt-wound dynamo-electric generator. This generator is provided with suitable brushes or collectors, a' and a^2, from which two conductors, 1 and 2, lead to a pole-changing transmitter, K′. The conductor 1 unites with the lever b' of the transmitter, and the conductor 2 bifurcates through two adjustable resistances, b^2 and b^3, to two contact-stops, b^4 and b^5, against which two contact-levers, b^6 and b^7, respectively impinge. The lever b' is actuated by an electro-magnet, B′, the circuit through which is completed by a finger-key, k', in a manner which will hereinafter appear. When the magnet B′ is not vitalized, the lever b' holds the contact-lever b^6 away from the stop b^4, while the lever b^7 is allowed to rest against its stop b^5. When the magnet B′ is vitalized, the contact-lever b^6 is brought into contact with its stop b^4, while the contact-lever b^7 is simultaneously separated from its stop b^5.

The contact-lever b^7 is connected by a conductor, 3, with the earth at E′, and the contact-lever b^6 is connected by a conductor, 4, with two branch conductors, 5 and 6, which divide at the joint 7. The conductor 5 includes one coil of each of two differentially-wound receiving-instruments, S′ and S², and connects with the main line L at a point, 8. The other branch conductor, 6, leads through the remaining coils of the same instruments, and is connected at a point, 9, with an artificial or equating line, l'. It will therefore be understood that a current will be sent to the main and artificial lines L and l' from one pole or the other of the generator A, according to the position of the transmitter-key K′.

The pole-changing transmitter K′ is preferably so adjusted that a complete interruption of the circuit between the dynamo A and the line L is made at each alternation of the current. For this purpose the points b^4 and b^5 are adjusted in such a manner that the lever b' will separate from the contact-lever b^6 a perceptible time before making contact with the lever b^7, and vice versa. A resistance, r, is included in the conductor 2, and this resistance is preferably bridged over by a condenser, c, which serves to take up a charge contrary to the extra charge given off upon breaking the dynamo-circuit, thus eliminating the spark, which has heretofore been found a source of trouble in using high-potential dynamo-currents.

In constructing the generator it is preferred to employ the organization known as the

"shunt-wound dynamo," and for the purpose of obtaining quick action a laminated field-magnet is employed, the inductive effect being thus more nearly allied to that of the armature, which is also laminated.

For the purpose of producing variations in the strength of the currents for operating a second receiving-instrument, a circuit is derived from the field-magnet coils A′ and A² of the generator. (Shown in diagram.) For this purpose a conductor, 11, is led from a certain point, 12, in the coil A′ to the lever c' of the transmitter K². The contact-point c^2 of this lever is connected by a conductor, 13, preferably including a resistance, r^2, to a point, 14, in the other field-magnet coil, A². The points 12 and 14 are by preference adjustably located in the field-magnet coils.

An artificial resistance, r', is included in the conductor 10, which unites the inner ends of the field-magnet coils A′ and A² of the generator A. The electro-magnet B² is vitalized when the key K² is closed, whereupon the lever c', coming in contact with the stop c^2, completes the circuit from the point 12 directly to the point 14, thus throwing a shunt across the remaining position of the field-magnet coils and the resistance r'.

Assuming that each and every turn of the wire of the field-magnet produced an equal magnetic effect, then the resistance r' should be equal to the resistance of the armature; but as the outer turns have in fact a much lower efficiency the resistance r' may be much less than that of the armature. In some instances it is desired to reverse the conditions, and in such case by suitably balancing the resistances r' and r^2 the action of the relay at the distant station which responds to the key K² may be accelerated or retarded, as desired. Thus if the resistances be so proportioned that the field strength is made to fall by the closing of the transmitter K² the action of the corresponding relay will be retarded, owing to the counter electro-motive force set up by the field-magnet upon its discharge, which slightly prolongs the current. If, on the other hand, the field strength be increased by the transmitter K², then it will discharge more quickly, because the counter electro-motive force developed by the field-magnet cores will intensify this action. It should be here noticed, however, that in practice the magnetism of the field-magnets of the generator remains almost constant under all positions of the keys. The magnetism which it would tend to lose when a portion of its coils are shunted by the closing of the key K² is compensated for by the increase in the volume of the current in the active coils.

Harmonic, alternating, or vibratory impulses are obtained by means of a third transmitter, K³, which serves to complete a circuit through the coils of a revolving series of electro-magnets, f' f', and to thereby induce in the stationary magnets F′ and F′ in proximity to the same impulses dependent upon the vitalization and rapidity of motion of the first-named magnets. The coils of the electro-magnets f' and f' are preferably included in a special conductor, 16, leading from one of the brushes, a^4, of the supplemental armature a of the generator to a contact-lever, d', of the transmitter K³. The contact point d^2 is connected by a conductor, 15, with the remaining brush, a^3, of the supplemental armature. When the lever d' is away from its magnet B² and against the stop d^2, the magnets f' f' will be vitalized, and as they are kept rotating by suitable power within the fields of the magnets F′ F′, they will establish in the latter impulses dependent upon their rate of revolution and the duration of their vitalization. The magnets F′ F′ are included in the conductor 3, leading to the earth at E′. It will thus be seen that rapidly-recurring impulses produced by this apparatus are normally superposed upon the currents upon the line. By depressing the key K³ and actuating the transmitter K³ the circuit of the magnets f' f' is interrupted.

For the purpose of insuring sharp definition of the impulses, a commutator is applied to the shaft of the revolving magnets f' f', and the conductor 3 leads to a brush, f, resting against and making contact with a series of stops or contact points, f^2 f^2, upon the shaft. The conductor 3 is connected with these points independently of the electro-magnets F′ F′. The points are so adjusted that the commutator will keep the line-coils cut out, except at the instant of passage of the poles of the magnets f' f' across the poles of the magnets F′ F′. This construction diminishes the resistance in the circuit and materially sharpens the definition of the harmonic vibrations.

It may be desirable to arrange the apparatus in such manner that the harmonic impulses may pass by the generator without traversing its coils. For this purpose a condenser, c^5, may be inserted between the conductors 1 and 2 leading to the key K′.

It is preferable that currents required for vitalizing the transmitter-magnets B′ B² B³ shall also be derived from the supplemental armature a, and to effect this a conductor, 17, leads from the brush a^3 through the electro-magnet B³ to the contact e^3 of the finger-key k^3. The lever of this key is connected by a conductor, 18, back to the brush a^4. A branch conductor, 19, leads from the conductor 17 to the key K′, and the anvil e' of this key is connected by a conductor, 20, through the magnet B′ to the conductor 18. Likewise a conductor, 21, leads from the conductor 17 to the key k^2, and the anvil of the latter, e^2, is connected by a conductor, 22, through the coils of the magnet B² back to the conductor 18. In this manner the local currents required for operating the several transmitters may be derived from the coils of the supplemental armature a.

The receiving-instruments S′, S², and S³ are operated by incoming, but do not respond to outgoing currents. For this purpose the two instruments S′ and S² are differentially wound,

as already shown, and the harmonic instrument S^3, which is also provided with differential coils, is included in conductors 23 and 24, leading, respectively, from the main line L′ and the artificial line l' through the respective coils to corresponding plates of two condensers, C′ and C^2. The remaining terminal plates of these condensers are united through the artificial resistance r^3. A contact-switch, h, applied to this resistance and capable of being moved along its length, is connected by a conductor, 25, with the conductor 4 at the point 7. It will be evident thus that the condensers C′ and C^2 will take a charge depending upon the potential at the point 7, and that the charge upon the two may be made equal by means of the adjustable switch h and resistance r^3. It is evident that outgoing currents will not affect the instrument S^3, but an incoming current will modify the charge of the condenser c' irrespective of the charge of the condenser c^2, and thus actuate the instrument.

The receiving-instruments S′ and S^2 are designed to be employed for closing the local circuits of two sounders, T′ and T^2, respectively, and a convenient method of accomplishing this consists in connecting the coils of these sounders in conductors 26 and 27, respectively, which lead from the conductor 17. The conductors 26 and 27 are connected with front contact-points, g' g^2, respectively, applied to the levers g^3 and g^4 of the receiving-instruments S′ and S^2. The last-named levers are connected by the conductor 28 with the conductor 18, and thus the instruments T′ and T^2 will respond to currents derived from the generator A when their respective levers are upon their working-contacts.

A resistance-coil, R, bridged by a condenser, C, is included in the artificial line l', in order to give it a resistance and electro static capacity approximately that of the main line.

The special organization of the system of receiving-instruments which it is preferred to employ is illustrated in Fig. 2. The main line L′ leads through the coils of a polarized relay, S′, of the usual construction, and also through the coils u^2 of a neutral relay, S^2, and the coils w^3, applied to a permanent magnet, p, of the receiving-instrument S^3, and thence to the earth at E^2. As shown, the polarized receiving-instrument S′ is of the usual construction for closing the circuit of a local battery, o', through the sounder T′, when operated by currents of suitable character.

For the purpose of causing the armature s' of the instrument S′ to be actuated by a constant force, regardless of the strength of the current traversing the main line—that is to say, whether it is of normal strength or is increased to operate the instrument S^2—an equalizing-coil, u', surrounds the armature s', and is included in the circuit of the local battery o^2, which operates the sounder T^2. One pole of this battery is connected through the coils u' in such a direction as to neutralize the normal induced magnetism of the armature. The conductor from this coil leads through the sounder T^2 to the back contact-stop, v^2, of the lever s^2 of the sounder S^2. The lever itself is connected with the other pole of the battery. So long as the armature rests against the stop v^2 a current from the battery o^2 will traverse the coil u' and neutralize, say, two-thirds of the magnetism of the polarized armature. The currents of diminished strength, therefore, which are at such time upon the line L′ will act upon the polarized armature of diminished strength and thus operate it with determinate force, it being a well-known fact that the greatest working efficiency of a polarized relay is obtained when the permanent induced magnetism is of the same strength as that given by the arriving current. When now the current upon the line is increased, the circuit of the battery o^2 is interrupted and the neutralization derived from the battery ceases, so that the increased magnetism of the electro-magnet of the instrument S′ will be really equal by the increased magnetic strength of the armature.

For the purpose of preventing the armature s^2 of the neutral relay from falling back during the time which intervenes between the reversals in the increased current, a supplemental coil, u^4, is applied to the core of the electro-magnet of this instrument, and its terminals are closed through the supplemental magnet q^2, which acts upon the armature-lever s^2. A reversal in the line-current will cause a reversal in the polarity of the relay S^2, and such reversal will establish an induced current in the closed circuit, and thus cause the supplemental magnet to act upon its armature and hold the lever s^2 against the tension of its retractor during the momentary demagnetization of the core of the receiving-instrument S^2. In this arrangement the induced currents due to a reverse when the weak battery is on the line, also those due to a fall of current, are so trifling as to be neglected, only those given by a full-strength reversal being strong enough to give any appreciable effect.

The harmonic instrument S^3 is preferably constructed with a permanent magnet, p, having the coils w^3 applied thereto, and a diaphragm, s^3, as a substitute for the armature. A contact-point, v^3, upon the diaphragm is applied to a similar contact, v^4, upon a lever or arm, v^5. The vibrations of the diaphragm will make and interrupt the circuit of a local battery, o^3, through a sounder, T^3, when a succession of impulses are sent upon the line of such frequency as to set the diaphragm in vibration and prevent the sounder T^3 from responding. Other devices might be employed for actuating a local sounder by the vibrations of a diaphragm in lieu of the one shown.

A convenient method of supporting the diaphragm is illustrated in Fig. 3, wherein the plate s^3 is suspended by wires v^6 v^6. The wires are strained approximately at right angles to each other with a tension adapted to give inharmonic or neutral vibrations, as it is found that strings giving fundamental tones are

more or less sluggish in action, and that their vibrations are prolonged after the currents cease. Suitable adjusting-screws, v^7 v^7, may be applied for this purpose, if desired.

In Fig. 4 is illustrated an organization of circuits for the harmonic receiver, in which a condenser is employed for operating the instrument, its coils not being included in the main line. For this purpose a conductor, 29, leads from a point, 30, in the line L′ to one plate of a condenser, C^3. The other plate of this condenser is connected through the coils w^3 by a conductor, 31, leading to a point, 32, in the main line beyond the instruments S′ and S^2. It is apparent that the successive charges and discharges of the condenser C^3, occasioned by the harmonic impulses, will produce corresponding variations in the magnetism of the core p, and thus operate the instrument S^3. The diaphragm serves, when vibrated with proper frequency, to close the circuit of the battery o^4 through the coils of the reversing-magnet T^4, and its armature d^4 is then held forward so long as the vibratory current continues. This armature serves to complete the circuit of a local battery, o^3, when it is away from its electro-magnet, and thus operate the sounder T^3.

For the purpose of overcoming the jar which is sometimes occasioned by the charge of the current entering the condenser C^3, which, however, is only felt when the strong current is reversed, and then to a detrimental extent only when the circuit is of great length, an additional condenser, C^4, is employed. One plate of this condenser is connected with the conductor 29. The other plate is connected by a conductor, 33, with the contact arm w', against which the lever d^4 strikes. This arm preferably yields somewhat, and as the armature falls from its magnet it is withdrawn from its contact-point w^2. The latter is connected by a conductor, 34, through the coils of the magnet D^4, applied to the armature-lever d^4. Thence a conductor, 35, leads to the line L′ at the point 32. The charge in the extra condenser C^4 holds the lever d^4 forward during the jar on the diaphragm, caused by the line-currents entering the condenser C^3. When the vibratory current is upon the line and the diaphragm is moving, the circuit of the battery o^4 through the magnet T^4 is interrupted and the lever d^4 falls back. The connection between the lever w' and the stop w^2 is therefore interrupted.

I claim as my invention—

1. The combination, with a generator and a telegraphic main line, of a pole-changing key connecting one pole or the other of the generator with the line at will, and a second key having its lever and contact-point, respectively, connected with intermediate points in the field-magnet coils of the generator.

2. The combination, with a main line and a source of electricity, of three independent keys or transmitters, the first of which acts to reverse the connections of the source with the main line, the second to vary the electro-motive force of said source with reference to the main line, and the third to superpose rapid reversals of current upon the currents traversing the main line from an independent source.

3. The combination, with a source of electricity and a main line, of a key for reversing the connections of the source with the main line, a second key for varying the electro-motive force of said source, and a third transmitter for establishing electrical vibrations upon the main line, consisting of a revolving series of magnets, a stationary series of magnets, one of which series is connected in the main-line circuit and acted upon by the other series, and a circuit for vitalizing the latter series of magnets.

4. In a telegraphic system, a magneto-electric transmitter consisting of a revolving series of magnets, means for completing a circuit through said magnets at will, a series of coils surrounding said magnets included in the main-line circuit, and a circuit-controlling device for establishing a short circuit around said coils at predetermined points in the revolution of the first-named magnets.

5. The combination, with a source of electricity and main and artificial telegraph-lines, of two receiving-instruments having opposing coils, respectively, included in said lines, a pole-changing key applied to said source, a second key for varying the strength of current from said source, a third receiving-instrument having its respective coils included in condenser-circuits, respectively, leading from said source of electricity to the main and artificial lines.

6. The combination, with a dynamo-electric generator, of a pole-changing key applied thereto, a shunt-circuit around a portion of the field-magnet coils of said machine, a key for controlling the connections of said shunt-circuit, and an artificial resistance included in the portion of the field so shunted.

7. The combination, with a dynamo-electric generator, of a pole-changing key applied thereto, a shunt-circuit around a portion of the field-magnet coils of said machine, a key for controlling the connections of said shunt-circuit, an artificial resistance included in the portion of the field so shunted, and an artificial resistance in said shunt-circuit.

8. The combination, with a dynamo-electric generator and a telegraphic main line, of a transmitter for reversing the connections of said generator with the line, a condenser inserted between the conductors leading from said generator to said key, and a source of vibratory impulses connected with said main line through said key.

9. The combination, substantially as hereinbefore set forth, of a source of electricity, a pole-changing key for reversing the connections of said source with said main line, an artificial resistance included between said generator and said key, a condenser around said

resistance, and a second key for varying the strength of the current derived from said generator.

10. In a multiple-telegraph system, a source of electricity, a pole-changing key, and a current-varying key, in combination with a second source of electricity and a key for superposing currents from the last-named source upon the currents from the first-named source, substantially as described.

11. In a multiple-telegraph system, a vibratory transmitter consisting of stationary electro-magnets having their coils included in the main-line circuit, revolving electro-magnets having their coils included in an independent circuit, or vice versa, and a key for controlling the connections of the last-named circuit.

12. In a multiple-telegraph system, the combination, with a shunt-wound dynamo, a pole-changing key, and a current-varying key, of an additional armature applied to said dynamo, and receiving-instruments deriving their operating-currents from said additional armature.

13. In a telegraphic system, the combination of a polarized receiving-instrument, a neutral receiving-instrument, both included in the main line, a local circuit having its connections controlled by the neutral relay, and a coil acting upon the armature of the polarized relay included in said local circuit.

14. In a telegraphic system, the combination of a polarized receiving-instrument, a neutral receiving-instrument, both included in the main line, a local circuit having its connections controlled by the neutral relay, a coil acting upon the armature of the polarized relay included in said local circuit, and a sounder also included in said local circuit.

15. In a telegraphic system, the combination, with a polarized and a neutral relay included in the main line, of a supplemental coil applied to the neutral relay, and a second magnet applied to the armature of the neutral relay having its coils included in circuit with said supplemental coil, substantially as described.

16. In a telegraphic system, a vibration-receiving instrument consisting of a diaphragm, a polarized magnet to which it is applied, supporting wires or strings carrying said diaphragm, and a circuit-controller operated by the movements of said diaphragm.

17. In a telegraphic system, a vibration-receiver having its coils included in a bridge-condenser circuit around other instruments of said system, a relay responding to the movements of the harmonic receiver, a supplemental magnet applied to said relay, a second condenser around said instrument including said supplemental magnet, and a circuit-controller operated by said relay, substantially as described.

18. In a telegraphic system, a vibration-receiving instrument, a condenser-circuit including the same, a condenser-circuit around said instrument, a reversing-relay controlled by said harmonic receiver, a local circuit controlled by said reversing-relay, a sounder included in the same, and a circuit-controller operating to complete said second condenser-circuit upon the interruption of the local circuit, and vice versa.

19. The combination, substantially as hereinbefore set forth, with a source of electricity, of a pole-changing key, a conductor leading from one pole of the source to the key-lever, branch conductors leading from the other pole to two contact-points, an artificial resistance in each branch conductor, two contact arms or levers applied to said points and key-lever, and a main line connected with said arms, substantially as described.

20. In a system of electric telegraph, a dynamo-electric generator, a main-line circuit, controlling-keys determining the connections of the generator with the main line, electro-magnets operating said keys, receiving-instruments, and local circuits derived from said generator including said electro-magnets and receiving-instruments.

21. The hereinbefore-described method of rendering the action of a polarized armature constant under the conditions of actuating-currents of varying strength, which consists in decreasing its magnetism when influenced by currents of less strength, and increasing its magnetism when influenced by currents of greater strength.

22. In a telegraphic system, a polar and a magnetizing coil acting on the polar armature, a neutral relay, a battery, a circuit therefor including said coil, having its connections such as to tend to neutralize the polarization of the armature, and a circuit-controller for said circuit operated by the neutral relay to interrupt the circuit when the neutral relay is traversed by a current of increased strength.

In testimony whereof I have hereunto subscribed my name this 27th day of July, A. D. 1886.

STEPHEN D. FIELD.

Witnesses:
CARRIE E. DAVIDSON,
CHARLES A. TERRY.