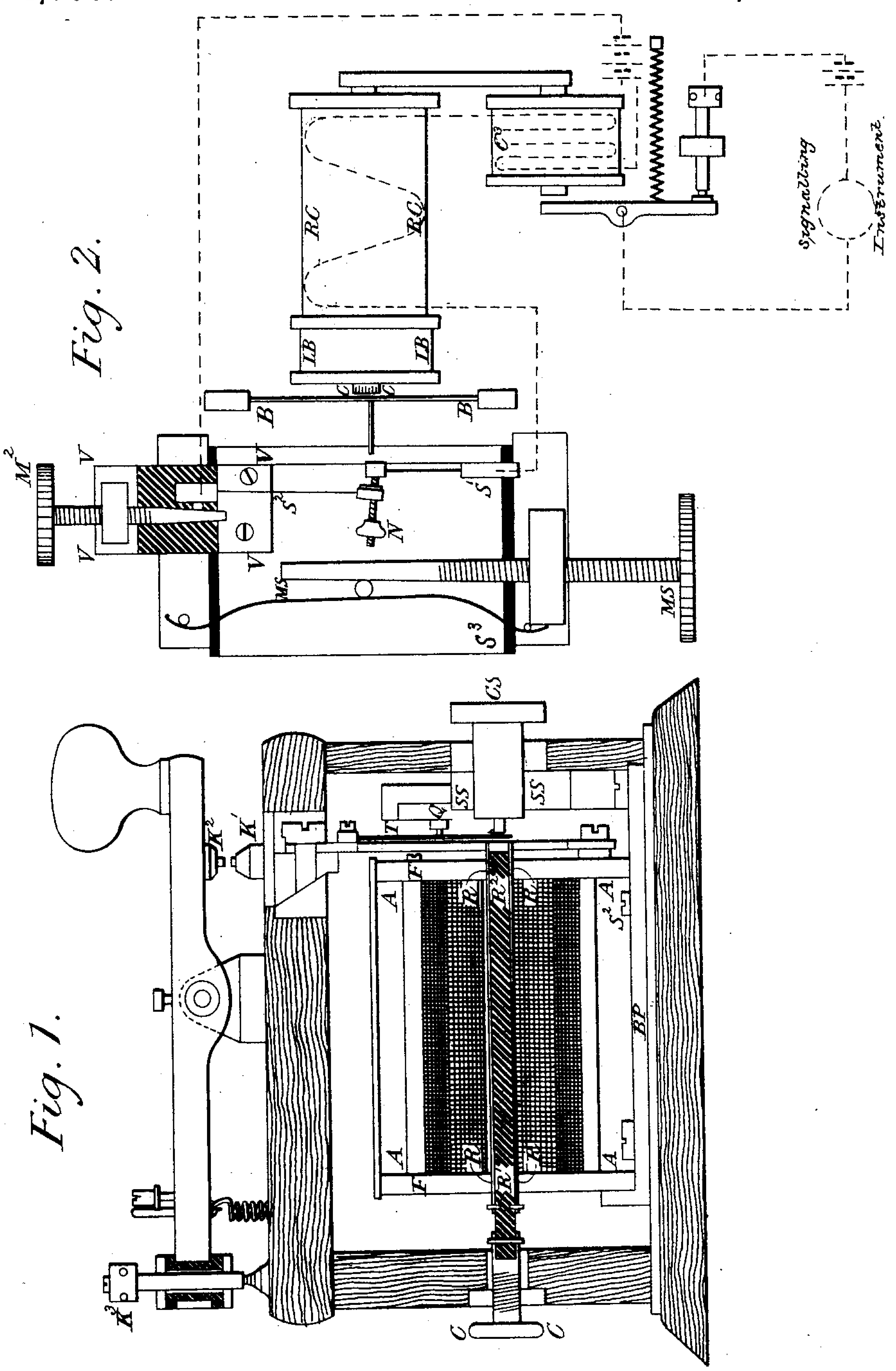
(No Model.) 2 Sheets—Sheet 1.

C. L. DAVIES.
TELEGRAPHY.

No. 424,006. Patented Mar. 25, 1890.



Witnesses
Lloyd B. Wight
Baltus De Long.

Inventor
Charles Langdon Davies.
By his Attys.
Baldwin Davidson & Wight

N. PETERS, Photo-Lithographer, Washington, D. C.

(No Model.) 2 Sheets—Sheet 2.

C. L. DAVIES.

TELEGRAPHY.

No. 424,006. Patented Mar. 25, 1890.

Fig. 3.

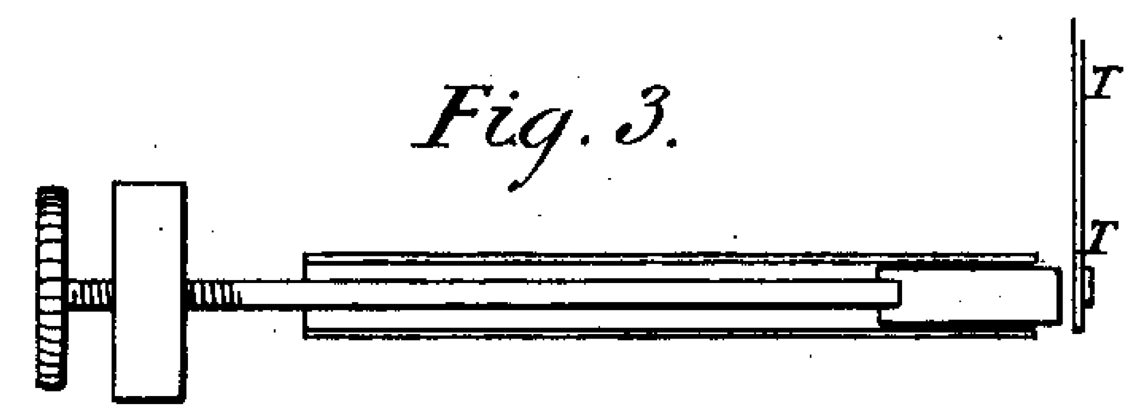


Fig. 5.

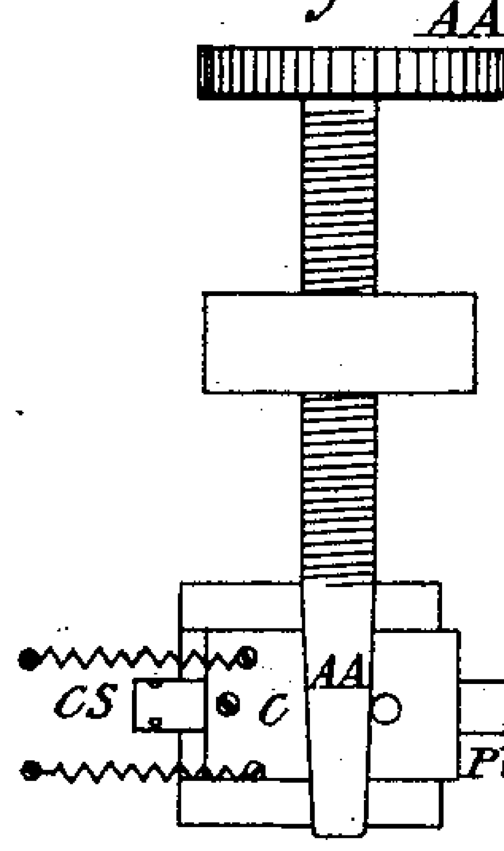
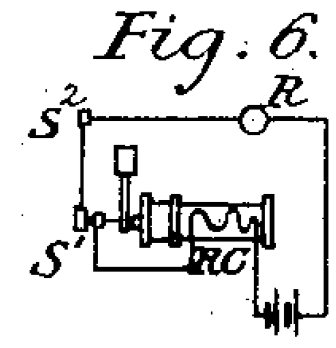


Fig. 6.



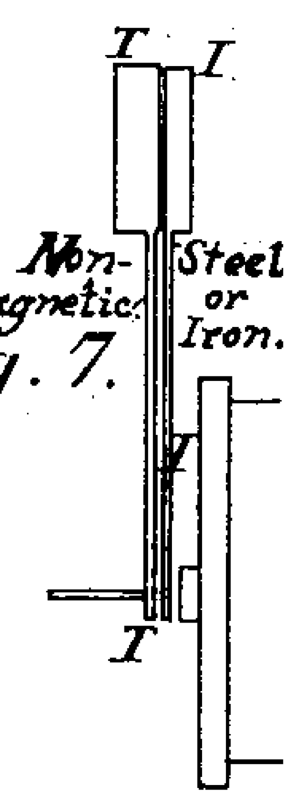


Fig. 7.

Fig. 4.

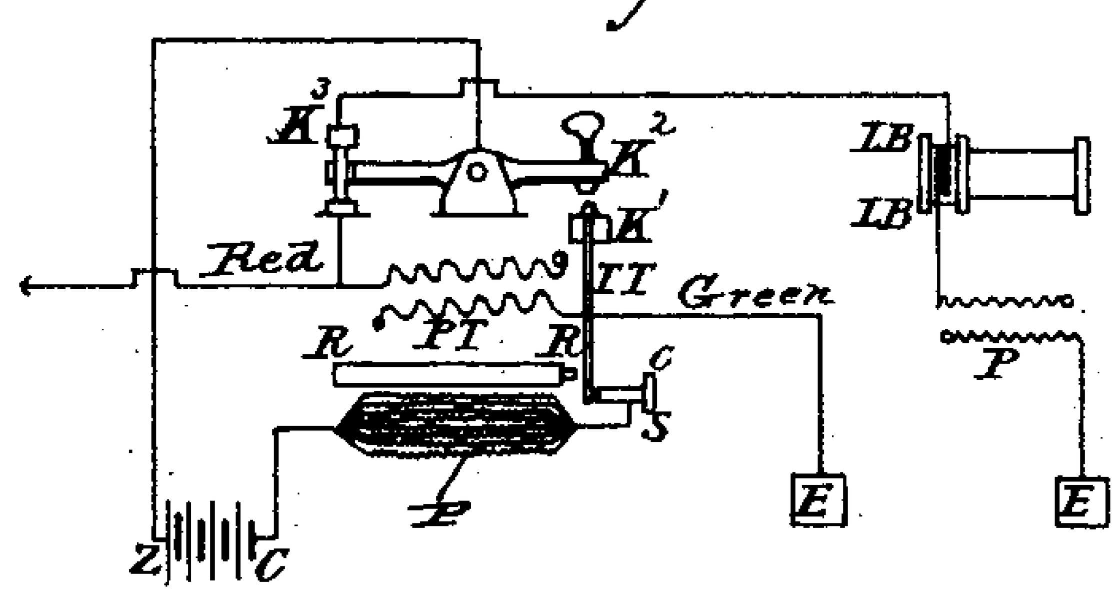


Fig. 8.

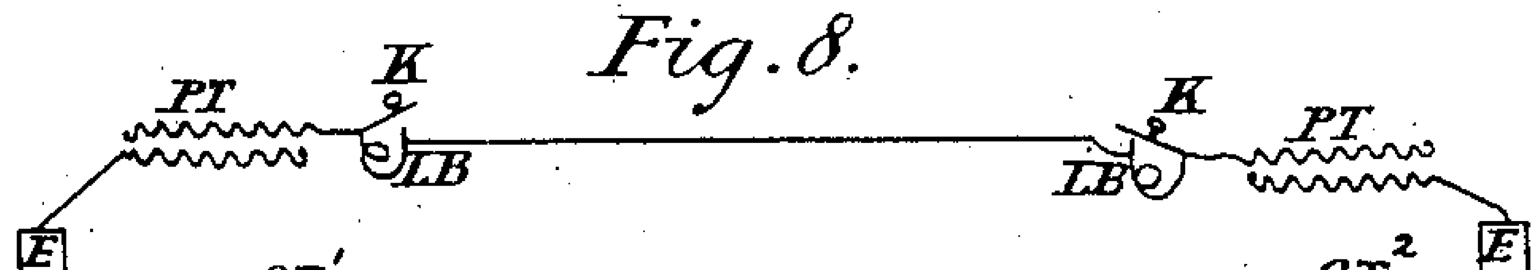


Fig. 9.

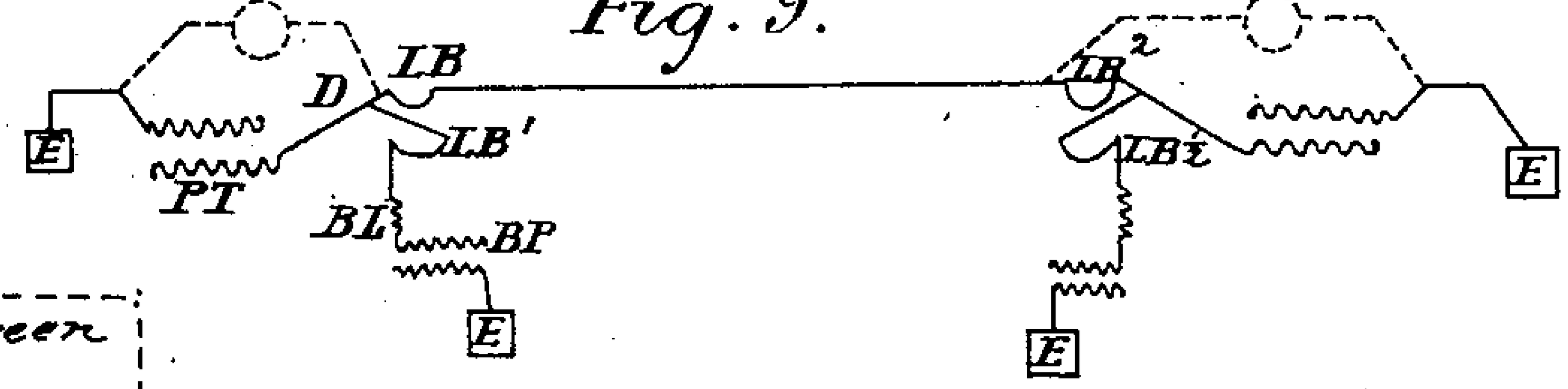


Fig. 4'.

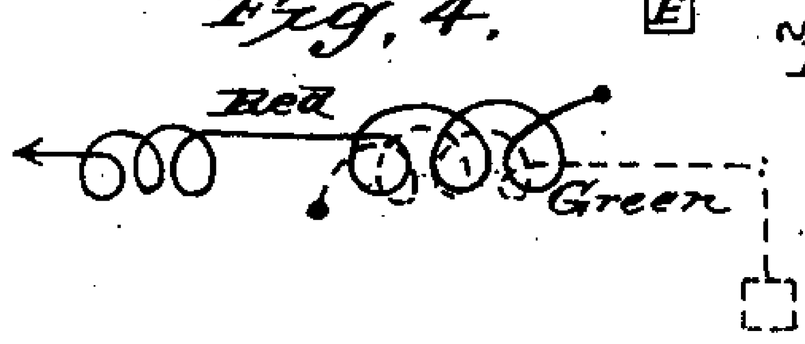


Fig. 10.

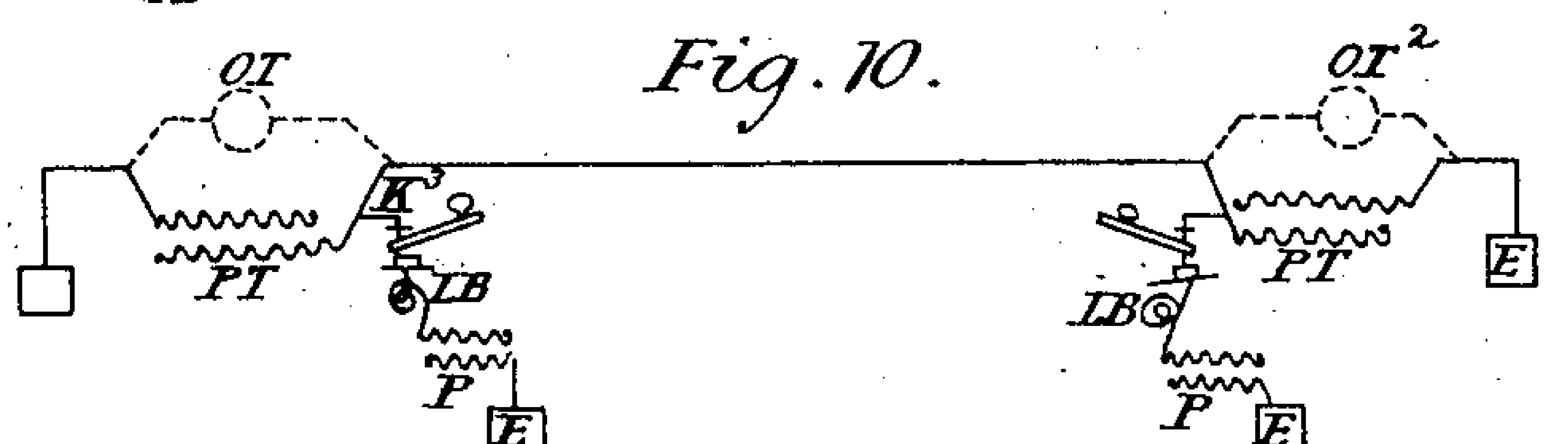


Fig. 11.

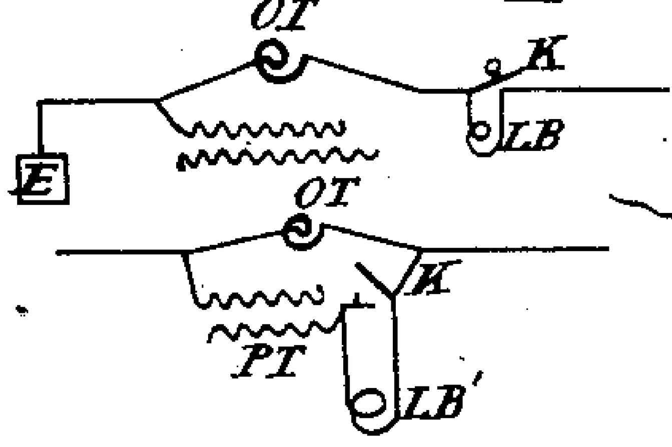


Fig. 12.

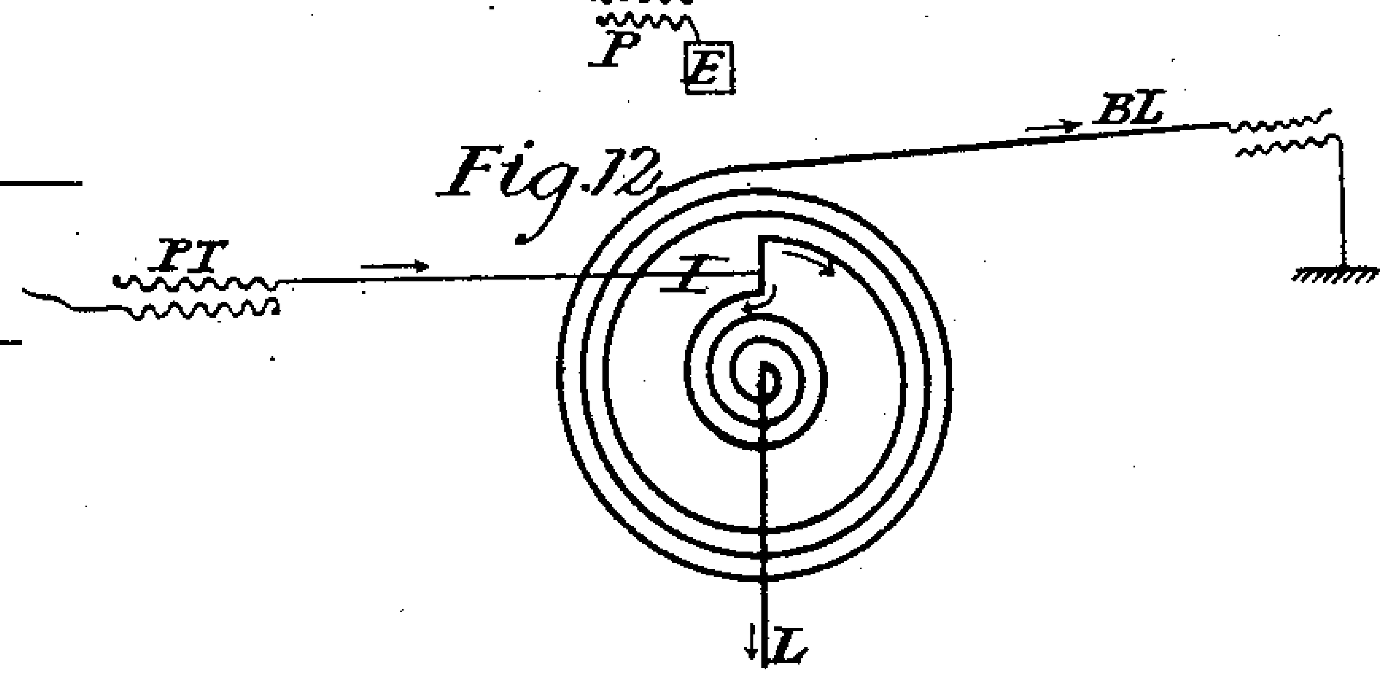


Fig. 13.

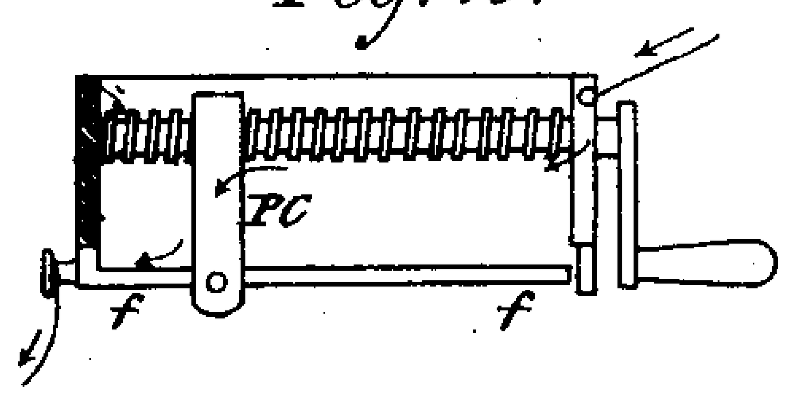
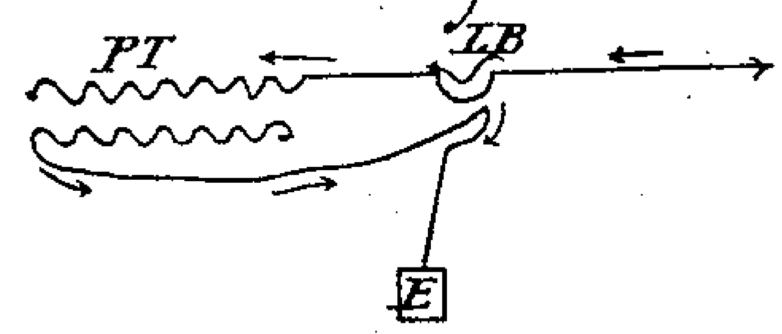


Fig. 14.



Witnesses
Lloyd B. Wight
Baltus De Long.

Inventor
Charles Langdon Davies
By his Attys,
Baldwin Davidson & Wight

UNITED STATES PATENT OFFICE.

CHARLES LANGDON-DAVIES, OF LONDON, ENGLAND, ASSIGNOR TO THE PHONOPORE SYNDICATE, (LIMITED,) OF SAME PLACE.

TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 424,006, dated March 25, 1890.

Application filed October 1, 1888. Serial No. 286,843. (No model.) Patented in England December 17, 1886, No. 16,616; in Germany November 1, 1887, No. 45,459; in France November 2, 1887, No. 186,734; in the East Indies December 5, 1887, No. 230; in Belgium September 20, 1888, No. 83,324; in Italy September 30, 1888, No. 24,129; in Spain December 17, 1888, No. 8,713, and in Canada April 11, 1889, No. 31,115.

To all whom it may concern:

Be it known that I, CHARLES LANGDON-DAVIES, electrician, a subject of the Queen of Great Britain, residing at 110 Cannon Street, in the city of London, England, have invented a certain new and useful Apparatus for the Employment of Vibratory Electricity in Telegraphy, (for which I have received Letters Patent in Great Britain, No. 16,616, dated December 17, 1886; in Germany, No. 45,459, dated November 1, 1887; in France, No. 186,734, dated November 2, 1887; in the East Indies, No 230, dated December 5, 1887; in Belgium, No. 83,324, dated September 20, 1888; in Italy, No. 24,129, dated September 30, 1888; in Spain, No. 8,713, dated December 17, 1888, and in Canada, No. 31,115, dated April 11, 1889,) of which the following is a specification.

By the words "vibratory electricity" I intend to describe a rapid succession of exceedingly brief electrical impulses, movements, or currents—such, for example, as those produced in the secondary of an induction-coil by the make and break of the primary circuit. I do not, however, insist that the impulses shall be induced. They may be brief direct currents from a battery, they may be all in the same direction, or may be alternating; but I prefer that they shall be those impulses which I find are capable of being produced in an electro-tonic field not necessarily including a conducting-circuit, as hitherto understood, and which I have described in a previous British patent, dated April 11, 1885, No. 4,506, as phonoporic impulses.

I include among the means of producing vibratory electricity all kinds of dynamo-electric machines, magneto-electric machines, influence-machines, induction-coils, and other similar apparatus capable of producing extremely brief minute impulses in rapid succession, which, in consequence of their brevity and rapidity, among other reasons, are not capable of working ordinary telegraph-instruments. I prefer that when any instrument, except a phonopore is used to produce vibratory electricity it shall be connected to the line through a phonopore or through a condenser, though the latter is not so well suited to the purpose as a phonopore.

In the accompanying drawings, Figure 1 is a side view, partly in section, of the transmitter. Fig. 2 is a plan of the receiver. Fig. 3 shows modification in detail of the transmitter. Fig. 4 shows schematically the circuit arrangement at one of the terminals; Fig. 4′, a similar view showing a modified arrangement. Fig. 5 shows a modification in another detail of the transmitter. Fig. 6 shows schematically the local circuit of the receiver. Fig. 7 shows a modification in a detail of the receiver. Fig. 8 shows a modification in the circuit arrangement in respect to the position occupied by the line-bobbin of the receiver. Fig. 9 shows schematically the circuit arrangement for duplex working and also for ordinary telegraphy on the same line. Fig. 10 shows schematically the circuit arrangements for simplex working in conjunction with ordinary telegraphy. Fig. 11 shows modifications of the circuit arrangement for simplex working. Fig. 12 shows schematically a line-bobbin wound for duplex working and its connection in circuit. Fig. 13 shows a rheostat for adjusting the resistance of the artificial line for duplex working. Fig. 14 shows an alternative method for connecting a duplex-wound line-bobbin in circuit.

Fig. 1 represents my transmitter. The frame is of wood, as indicated, or of other insulating material. It contains a bobbin A A A A, constructed as follows: The core R, Fig. 1, consists of a split tube of soft iron, which may conveniently be three and three-fourths inches long and three-tenths of an inch external diameter. It must fit the flanges F F closely, so that it shall not vibrate. To facilitate the adjustment of the front end of the core toward the reed or tongue T T, I sometimes provide the core with a movable pole-piece (shown separately in Fig. 3) consisting of an iron pin screwed into the front end of it nearest to T T and operated by the brass rod fixed to the pin running through the length of the core to an adjusting-screw at the back of the instrument, or the pin may be dispensed with and the whole core made to move, as shown in Fig. 1, in which case the core should be stuffed with a rod of vulcanite R′ R², to which it may be fixed by two or more pins. It is advisable that these pins should not touch each other or bring two parts of the core into metallic contact. The vulcanite rod is continued toward and fixed to the adjusting-screw C C. This arrangement permits the whole core to be adjusted toward the reed. Upon the core, or as near thereto as may be, I wind the primary coil, which serves to magnetize the core and causes it to act on the reed T T when the circuit is closed through the battery. A rapid interruption of the current—such as is necessary in these instruments—is accompanied under ordinary circumstances by a succession of sparks, which damage or destroy the contacts and thereby throw the instrument out of action in a very short time. To obviate this I construct the magnetizing-coil in layers of separate wires instead of in the ordinary way.

The primary coil of my transmitter is a multiple-wire coil, which I construct as follows: I wind a single layer of insulated wire—say .009 of an inch in diameter—and bring out both ends. Over this I wind another layer and bring out the ends in the same way, and so I wind layer after layer separately until I have a sufficient number of layers—say about fourteen. I solder or otherwise connect the free ends of all these layers at one end of the coil together, and do the same with the wires at the other end of the coil. This is indicated in Fig. 4.

Fig. 4 shows schematically the connections of the primary circuit, and Fig. 1 shows the working parts.

Z C is the battery, to which is connected one of the combined ends of the primary coil P, and the other combined end is connected to the contact-screw C S. This contact-screw is placed in proximity to the reed or vibrator T T, preferably tuned to a given note or rate of vibration, supported on a frame which is fixed to and forms part of the lower front contact K′ of the key. The upper front contact K² is connected, through the middle point of the key or otherwise, to the battery, thus completing the primary circuit. When the key is put down it does two things: It mechanically jars the reed by striking on a piece with which it is rigidly connected, and so sets up a slight tremor in it, and it also closes the battery-circuit through the reed. This jarring is an advantage in starting vibrations of the reed, and reduces the necessity of pressure between the reed and contact-screw C S. Especially when I desire to use this transmitter for harmonic telegraphy, I seek to render the action of the reed as free as I can, so that it may have as much influence as possible in governing the rate at which the primary circuit is made and broken. With this object I arrange that when the key is put down it will close the battery-circuit through the primary coil P through a weak slow-acting spring or pendulum Q, Fig. 1, connected with C S or the metal bushing S S, in which it works, in contact with the reed. At this time the reed is not necessarily resting upon the screw or stud C S, with which it makes its working contacts, for this would interfere with the complete freedom of vibrations of the reed, which it is important to retain. The first movement of the reed throws the slow-acting spring Q out of action, and the vibrating reed then makes its own contacts with the studs C S and continues to vibrate as long as the key remains depressed.

The currents in the primary coil generate the impulses in the secondary phonopore P T, which I construct as follows: Fig. 1 shows the working parts, and Fig. 4 the connections. Upon the bobbin of the transmitter, over the primary coil, I wind two insulated wires side by side. No. 36, Birmingham wire-gage, is a suitable diameter. For the sake of distinction I will call these wires red and green. The commencement of the red wire is connected to the line, and the commencement of the green wire is insulated, Fig. 4. When a sufficient length of these two wires—say six hundred yards—is wound side by side upon the coil, the end of the red wire is insulated and the green wire is connected to earth. These two wires are thus completely insulated from each other.

A modification of this arrangement which I find advantageous under some circumstances is as follows: I at first wind the red wire alone, the inner end being connected to the line. I coil this single wire to a suitable deph—say half an inch—and I then commence with the green wire, the inner end of which I insulate, and I complete the secondary by winding the green and red wires together side by side over the first winding for a length of about five hundred yards. The outer end of the red wire is then insulated and the outer end of the green wire is connected to earth. There is thus no conducting-circuit through the secondary. This is shown schematically in Fig. 4′, where the solid line represents the red wire and the dotted line the green wire.

To adjust the contact-stud C S, which requires accurate setting, I sometimes employ a screw with a taper or conical projecting end A A, Fig. 5. The stud C S is then fitted into a carrier C, and the stud with its carrier is held against the taper end of the screw by springs. This taper end acts as a wedge to set forward the stud or allow it to retire. The platinum wire or other contact-piece P W on the stud, here represented on the reverse side, is sometimes placed out of the center. When, therefore, the stud is turned in its carrier, the contact-piece is brought to bear upon a fresh surface in the contact-plate of the reed, which consequently requires cleansing, repairing, or filing less frequently. As long as the key is held down, thereby closing the primary circuit, a rapid stream of short currents flows through the primary coil. The rate at which these currents are commenced and interrupted is regulated by the vibrations of the reed. The currents generate in the secondary phonopore rapid electrical impulses of great intensity and infinitesimal duration, and these impulses travel in the line. When an induction-coil is used to generate these impulses, the various organs of the transmitter are constructed in the same way, except the secondary phonopore, which is replaced by a secondary coil connected to earth or to line through a phonopore instead of by a conducting-wire. Any other apparatus used to generate the rapid vibratory impulses required should also be connected to earth or line through a phonopore.

Fig. 2 represents a front elevation of the receiving-instrument, which translates the rapid series of electric impulses or vibrations coming from my transmitter or any of the transmitting-instruments herein described, of which series of impulses each signal is composed, into a single current capable of working ordinary telegraph-instruments in a local circuit.

The bobbin L B upon the soft-iron core C C I call the "line-bobbin." There are usually two coils in the line-bobbin, especially when the receiver is to be employed for duplex working, although for simplex working a single coil is generally sufficient.

R C R C is the re-enforcing coil wound on the same core, but forming part of a separate local circuit in which there is a permanent current from a battery maintaining a charge of magnetism in the core, except when the circuit is disturbed by signals, as hereinafter described. This local circuit is shown schematically in Fig. 6. It passes from the battery through the coil R C to the tongue S′, which touches the pendulum S^2, and, if required, through a relay R of ordinary construction to the battery. Such relay when employed would include in its own local circuit a printer, sounder, or other instrument with its battery.

In front of the line-coil L B, Fig. 2, there is a reed or steel blade B B, which reed is brought into close proximity to the end of the core. The reed may be fixed at both ends, as in the drawings, Fig. 2, or it may be free at one end, as in Fig. 6. The core is a split iron tube and may be provided with an adjustable pole-piece similar to that described in the core of the transmitter. It is convenient to place a pin upon the reed projecting toward the tongue S′. Variations in the magnetism of the core resulting from vibratory impulses in the line-coil L B, arriving in rapid succession from the line, set the reed in motion, and when the motion is sufficient it strikes the metal tongue S′, disturbing or impairing its contact with the pendulum S^2. This disturbance reduces the current in the coil R C, and therefore the magnetism in the core resulting from it. Now, this magnetism was holding the reed in a state of tension toward the core. The reduction of the magnetism reduces this tension. The result is that the amplitude of the vibration of the reed is increased and it strikes a blow upon the tongue S′, which causes the pendulum S^2 to break contact. This contact would, however, be immediately renewed if the vibrating organs were at rest; but the impulses in the line-bobbin, continuing to arrive in rapid succession, maintain the tremor in the reed, which tremor is communicated to the tongue, and this very effectually, because the reed, being no longer drawn toward the core, is pressing upon the tongue. The result is that contact between the tongue S′ and pendulum S^2 is not again perfected until the cessation of the vibratory signal coming from the line permits the reed to be at rest. The instant that this takes place the reed is drawn away from the tongue toward the core ready for the next signal. By this means a rapid succession of minute impulses is made to give a signal of any required length. The current which magnetizes the core also holds up the armature of the local relay, which falls whenever the contact parts S′ and S^2 are separated or their contact impaired. This relay thereby works a printer, sounder, or other telegraph-instrument in the local relay-circuit. If the tongue and pendulum are placed out of reach of the reed, the vibrations of the reed will have no effect upon the relay. If they are now brought nearer, they may be so placed that vibrations reaching a certain amplitude shall effect their contact and so work the relay, while other vibrations not attaining the necessary amplitude will have no effect and will never bring the re-enforcing coil into action.

I so arrange the reed, tongue, and pendulum that contending currents or impulses—that is to say, other impulses than my own—produced in the wire at the same time as those I wish to employ shall not work my receiving-instrument. For this purpose I place the tongue S′ only so near the reed B B as that it will not be struck unless the reed is caused to vibrate by impulses repeated at such a rate as to support each other in their action upon the reed, and so that a single impulse or a series of impulses not arriving at the rate required by the natural rate of the reed will not cause the reed to vibrate with as much amplitude as is necessary to enable it to strike the tongue with the force required to cause it to act upon the pendulum. In order to do this I require a micrometrically fine and very solid adjustment, which I construct by means of a screw with a tapering or conical end, as before described, and shown in Fig. 2, M S M S. The tongue S′ is mounted upon an insulated slide S^3, which also carries a support V V V V, in which is another slide of vulcanite or other insulating material, on which the pendulum is mounted, and a similar screw may be provided therewith to adjust the pendulum toward the tongue. The slide is provided with a pin, which is kept pressed upon the cone by a spring. I first adjust the pendulum toward the tongue by means of the screw M^2 or in the alternative by screwing the nut N on the pendulum, nearer to or farther away from the end. I then adjust the whole by means of the screw M S at the exact distance from the reed which will permit it to work the receiver only when the proper signals arrive. As an additional means of accomplishing this object and when the contending currents are very severe, I use a dual reed, as shown in Fig. 7. It consists of two reeds—one I I of steel or iron, the other T T of non-magnetic material. The two reeds are tuned in unison and placed in close proximity to each other, the steel or iron reed being close to the core and acted upon by the variations in its magnetism. These variations have no effect on the non-magnetic reed; but if this steel or iron reed vibrates at the proper rate of the non-magnetic reed the non-magnetic reed will vibrate also. Contending currents will affect the steel or iron reed, but cannot affect the non-magnetic reed or tongue S′. Only when the magnetic reed is vibrated at its proper rate can it cause the non-magnetic reed to vibrate, and then the non-magnetic reed sets the tongue in action. These arrangements also assist the duplex action of the receiver, and the balance-line does not require the frequent adjustment which has hitherto been necessary in duplex telegraphy, because the rate of vibration of the local transmitter not being the same as the rate of vibration of the local receiver, it has less tendency to actuate the local receiver, and the outgoing impulses from the transmitter are to some extent in the nature of contending currents toward the receiver attached to it. When there are no contending currents to deal with, these arrangements are generally unnecessary, and the contact which works the relay-circuit may be direct from the pendulum to the reed.

When I desire to avoid the use of a separate instrument as a relay, I cause my receiving-instrument to act as its own relay, by making the following modifications in it, and I then call it a "transformer." Upon the end of the core opposite the line bobbin or bobbins I place an iron armature, which supports an additional pole-piece, upon which I place another bobbin C^3, Fig. 2, and I am still able to adjust the front pole-piece with respect to the reed, as before described. Upon the relay pole-piece I place the coil C^3, which is in circuit with the re-enforcing coil, and the object of which is to concentrate magnetic action upon the relay pole-piece. I place near to this pole-piece an iron armature, which when held up by a charge of magnetism breaks the local circuit containing the signaling-instrument, and which when released by the discharge of magnetism consequent on the action of the tongue-and-pendulum contact completes the local circuit and works the signaling-instrument. This is indicated by the dotted circuit-connections in Fig. 2.

It is advisable to construct the iron parts comprising the relay of solid iron and somewhat heavy, so that the action of the relay may be sluggish as compared with that of the tongue-and-pendulum contact. By this means the vibrations entering the instrument are transformed into the visible or audible signals used in ordinary telegraphy.

When the signaling-instrument is in circuit with the re-enforcing coil, or when a very large battery-current is employed therein, I make the re-enforcing coil of multiple wire in layers, as previously described, to moderate the spark at the contacts.

In duplex working I wind two coils in the line-bobbin L B, Fig. 2, and I so connect them that all impulses originating at the home station divide between the two coils and counteract each other, one part going to the line, the other to an artificial or balancing line, hereinafter described. The impulses arriving from the distant station, on the contrary, operate in the same sense in each coil. This arrangement is indicated in Fig. 9. The impulses from the transmitter P T divide in the line-bobbin L B L B′ and counteract the effect of each other on the core, but flow in the same direction of the coils of $L\ B^2\ L\ B^{\frac{1}{2}}$, where they conspire with each other to affect the core. The balance-line B L usually contains a resistance, and it has this peculiarity: It has no through-circuit, but terminates in one of the wires of a phonopore B P, composed of two insulated wires, each, say, about five hundred yards in length, laid side by side throughout their whole length upon a bobbin or other convenient receptacle. One end of the first of these wires is connected with the balance-line and the other end insulated, and one end of the second of these wires is connected to the earth and its other end insulated. I proportion the two wires in the receiver-line bobbin as regards each other so as to form within the coil an approximate balance, or instead of one bobbin with two wires I use two bobbins with one wire each, one being very much smaller than the other, and connect one end of one of them to the main line and the other to the balance-line, as before described; or, instead of winding two wires side by side, as is usual in duplex coils, I wind one over the other, producing in effect a single-wire coil with an exterior connection to some point intermediate between the two ends, as well as connections at the ends. Fig. 12 shows such a coil. I is the intermidate connection, B L the balance-line, and L the line. Impulses from a local transmitter enter the coil at I and divide, neutralizing each other in their effect on the core. I prefer to arrange the proportions of the coil so as to put the greater part of its resistance in the balance-line and but little in the main line. A few layers of the wire wound nearer the core are sufficient to counteract the effect of a larger number of those farther from it. I therefore prefer to connect the balance-line to the outer end and the main line to the inner end of the coil.

My balance-line, being insulated, is not subject to the same loss of current as an ordinary balance-line.

The resistance which I employ in the balance-line is a rheostat consisting of a trace or film made upon a non-metallic surface with plumbago or other suitable conducting material. The trace may be made upon the edge or side of a strip of vulcanite, and the contact-piece is arranged to move along the trace of plumbago by means of a screw or other similar contrivance. In this way the distance which the current has to pass along the film or trace from the movable contact to the fixed contact is varied, so as to give the resistance required. In order to prevent the movable contact from wearing out the trace or film, I construct the contact-piece of the same plumbago or other material of which the film itself is composed, and thus constantly replenish and maintain the film while the instrument is in use. Fig. 13 shows this rheostat. P C is the plumbago-carrier; *f f*, the trace or film. The arrows indicate the course of the impulses or current, and the amount of resistance interposed is regulated by the handle. When a longer film is required, it can be supported upon the worm of a screw instead of a straight edge. A film of lower resistance is made by increasing the surface coated.

My method of duplexing the vibratory telegraphs does not require so accurate a balance as is necessary in ordinary duplex telegraphy, and the incessant adjustment of the balance-line is unnecessary. My arrangements for preventing the action of contending currents and the approximate balance in my duplex coil assist the object, which can almost always be completely attained by means of the rheostat described, which rheostat, however, may be replaced by ordinary resistance-coils. Considerable variations in the resistance of the main line may take place without disturbing the independent action of my duplex instruments. The use of the balance-line and the arrangements associated therewith in connection with my receiver also prevent injurious action upon my instruments from the shocks resulting from the use of the transmitter-key of an adjacent ordinary telegraph and other similar contending impulses.

When I do not desire to work a relay or ordinary telegraph-instrument, I omit those parts of the receiver which relate thereto and construct it only of the line-bobbin L B, re-enforcing coil R C, and the tongue and pendulum arranged to press upon the reed. The sound of the vibrations of the reed is then sufficient to give the signals.

The line-bobbin of the receiving-instrument may be connected either in the line-circuit, if there be a circuit, as shown in Fig. 11 at L B′, or between the line-circuit and transmitter, as shown at L B, Fig. 11, or between the line-wire and a separate phonopore inserted between it and the earth.

Figs. 4 and 10 show the connections of the transmitter and the line-bobbin of the receiver as regards the line in simplex working. In this case the line-bobbin L B is connected to the earth by a separate phonopore P and to the line through an insulated screw K^3, forming the upper back contact of the transmitter-key, and which is shown in Fig. 1. When the key is depressed for sending, the receiver is disconnected from the line. When the key is at rest, the receiver is connected to the line through the screw ready to receive the signals from the distant station. When the line-bobbin forms part of the line-circuit, a cut-out is provided at the back of the key, so that when the key is depressed in sending the line-bobbin is cut out, as indicated schematically at K in Figs. 8 and 11. In duplex working one of the coils of the line-bobbin is inserted in the line and the other in the balance-line and is connected with the secondary phonopore of the transmitter directly, as shown in Fig. 9, L B and L B^2.

Ordinary telegraph-instruments may be placed as shunts to my vibratory instruments, and will not be injuriously affected by them. The position of these shunts is shown in Figs. 9 and 10 by dotted lines, and also in Fig. 11. O T is the ordinary telegraph-instrument. The shunt may include both the transmitter and the line-bobbin of the receiver, or only the transmitter, or in the case of duplex working one coil of the line-bobbin L B, Fig. 9, or both coils, as at L B^2, Fig. 9. The connection of the ordinary telegraph to earth need not be at the same place as the earth-connection of the vibratory telegraph. The two forms of telegraphs may then be worked simultaneously on the same wire.

The vibratory telegraph is not necessarily combined with an ordinary telegraph system. It may be used with considerable advantage as an independent system. When this is done, it is worked with advantage on a line having no conducting-circuit, as is shown in Fig. 8, where P T is the transmitter and L B the line-bobbin of the receiver or transformer.

By omitting the dotted lines O T in Figs. 9 and 10 other methods of open-circuit working are shown, both simplex and duplex. In the simplex the line-wire is connected through a single-wire line-bobbin to one wire of a phonopore, which may be the transmitter, the other wire of which is connected to earth. In the duplex a double coil is necessary for the line-bobbin, having any of the forms previously described, and also the other parts of the balance-line. When the transmitter is an ordinary induction-coil or other instrument having a conducting-circuit through it, it may be placed in the line, which may then become a conducting-circuit, though not to advantage. The modes of connecting the receiving-instrument would be the same as in the case of my transmitter. A two-wire line-bobbin may on the open circuit be connected, as shown in Fig. 14, where the line-wire is connected through one wire of the line-bobbin to one wire of the phonopore, and the other wire of the phonopore is connected through the second wire of the line-bobbin to earth. The impulses passing in the earth-wire re-enforce those in the line-wire. The arrangements for dealing with contending currents may be dispensed with on the open circuit.

The arrangements of tuned reeds and for permitting their freedom of action enable harmonic instruments to be employed, so that a number of instruments governed by different notes may be worked simultaneously on one wire. Any or all of these services may be worked either simplex or duplex, and either with or without ordinary telegraphs working at the same time on the same wire.

In place of free reeds tuning-forks, reeds held at both ends, tuned strips of metal, and other means of regulating the rate of the vibrations may be employed under similar conditions, though not always with equal effect.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. The transmitter, substantially as described, consisting of a bobbin with numerous primary windings, whereby sparking is suppressed, and with secondary windings connected with the line each by one end only, and with a tongue, and with a core adjustable to vary its attraction on the tongue, and with a contact-point adjustable in relation to the tongue, and with a key opening and closing contacts, as herein set forth.

2. The transmitter, substantially as described, with primary windings and secondary windings, and with a core, and with a tongue attracted by the core, and with a key striking on a part to which the tongue is attached, and thereby serving to set the tongue in motion mechanically, as herein set forth.

3. In a transmitter, substantially such as described, the combination of the pendulous contact Q, to be connected with one terminal of the primary circuit, a transmitter or key K, to be connected with the other terminal of said circuit, a tongue T, with which said contact Q is in contact when at rest, and the stud C S, the parts being adapted to operate substantially as set forth.

4. In a transmitter, the combination, substantially as set forth, of the contact-point, the screw-threaded conical plug, the slide carrying the contact-point, the pin on the slide abutting against the plug, and the spring.

5. The receiver, substantially as described, consisting of a core with a line-bobbin and a re-enforcing coil upon it, the latter in a local-battery circuit closed through contact parts $S' S^2$, and of a reed which, when set in motion by suitable periodic impulses in the line-bobbin, strikes the contact parts $S' S^2$ and, keeping them in motion, opens the local circuit, as herein set forth.

6. In a receiver, substantially as described, the contact parts $S' S^2$, supported in proximity to a reed, said parts being adjustable in relation the one to the other, and adjustable together in relation to the reed, so that the reed may not act on the contacts to open the circuit in which the contact parts are included until its vibrations attain a certain amplitude, as herein set forth.

7. In a receiver, the combination, substantially as described, of the contact parts $S' S^2$, the screw-threaded conical plugs, the slides, the pins thereon, and the springs.

8. In a receiver, the combination, substantially as described, of the line-bobbin and core, the magnetic tongue in proximity to the core and agitated by it, and the non-magnetic tongue in proximity to the magnetic tongue and taking up its synchronous vibrations, the said non-magnetic tongue when in motion striking against contact parts S and S′, and thereby opening a local circuit, as herein set forth.

9. The combined receiver and relay consisting of the line-bobbin with its core, the re-enforcing bobbin on the same core, the relay-bobbin, the contact parts S′ and S^2, the local-battery circuit in which (excepting the line-bobbin) all the foregoing parts are included, and the tongue attracted and set in vibration by the core and operating upon the contact parts S′ and S^2 to open the circuit, as herein set forth.

10. In a receiver for duplex working, the combination, substantially as described, consisting of the line-bobbin electrically connected by its ends in the receiving-circuit and electrically connected by its middle in the transmitting-circuit, so that the outgoing currents divide, one half passing into the line-circuit and the other in the other direction around the coil into a balancing-circuit, the core within the bobbin, the tongue in proximity to the core, and the contact parts $S' S^2$ in a local-battery circuit, these parts being so arranged that the local circuit is opened by the action of the tongue upon the contact parts, as herein set forth.

11. The combination, substantially as described, for duplex working, consisting of the following instruments at each of two terminals stations connected together by a line-wire, viz: the herein-described transmitter of vibratory currents, the herein-described duplex receiver, and a circuit connecting these instruments inductively or actually, which circuit may be traced as follows: from earth through the secondary coil of the transmitter to the middle of the line-bobbin of the receiver, where, dividing, one branch leads to earth by the balancing-line and the other branch by the line-wire to the distant station, where the circuit may be further traced

through the line-bobbin from end to end and so to earth, completing the circuit.

12. The adjustable resistance or rheostat, substantially as described, forming part of a balancing-line and consisting of a line or trace of plumbago or like material and a stylus of the same material, which, as it is traversed along the trace by suitable mechanism in connection with it, continually renews the trace, as herein set forth.

13. The combination, substantially as described, for duplex working with vibratory electricity, of the transmitter of the vibratory impulses, the receiver of said impulses, a battery-circuit opened and closed by the receiver of vibratory impulses, whereby said impulses are translated into ordinary telegraphic signals, and the balancing-line with open circuit, as set forth.

C. LANGDON-DAVIES.

Witnesses:
WM. THOS. MARSHALL,
I. TOWNSEND THOMPSON.