No. 796,595. PATENTED AUG. 8, 1905.

A. MUIRHEAD.

TELEGRAPHIC TRANSMITTER.

APPLICATION FILED APR. 27, 1899.

3 SHEETS—SHEET 1.

Fig. 1.

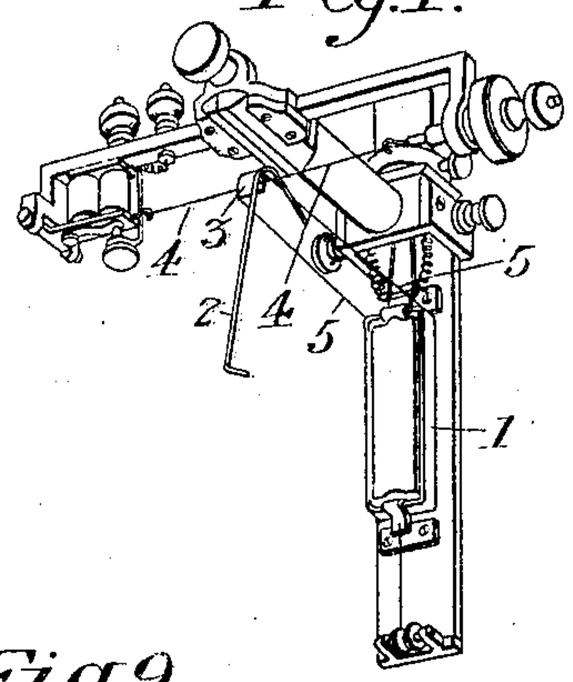


Fig. 2.

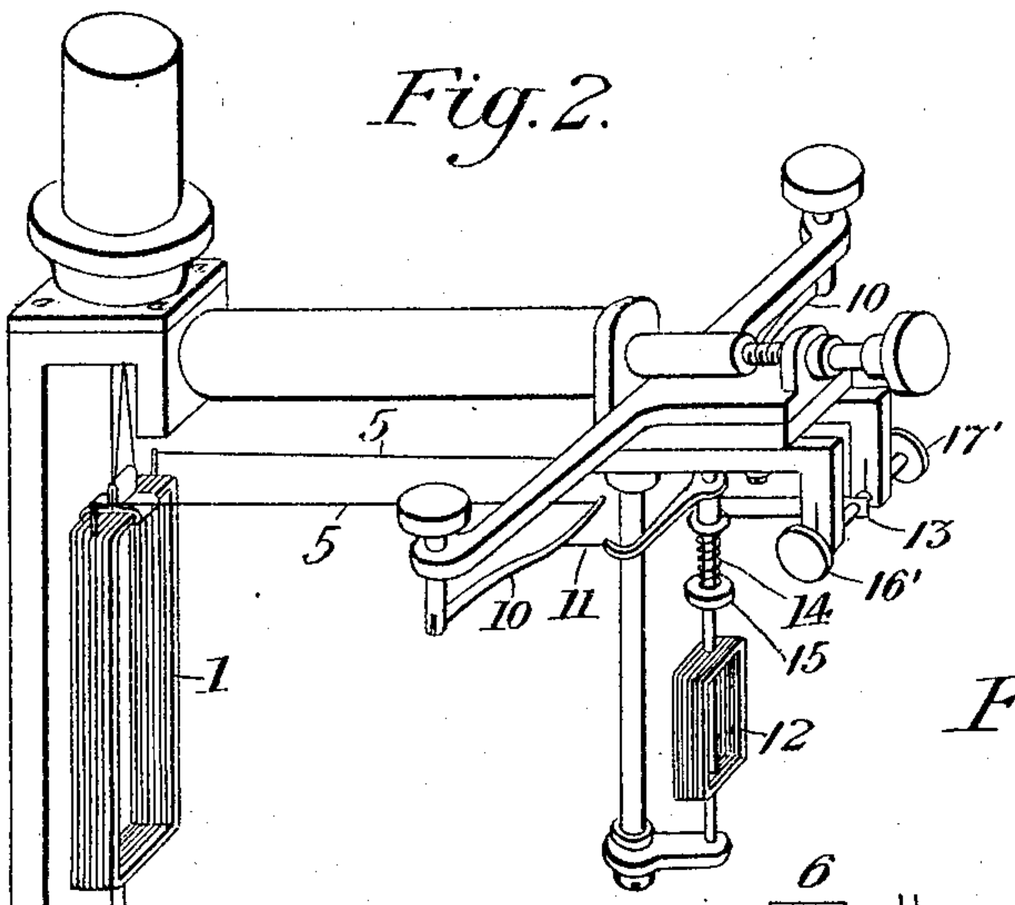


Fig. 9.

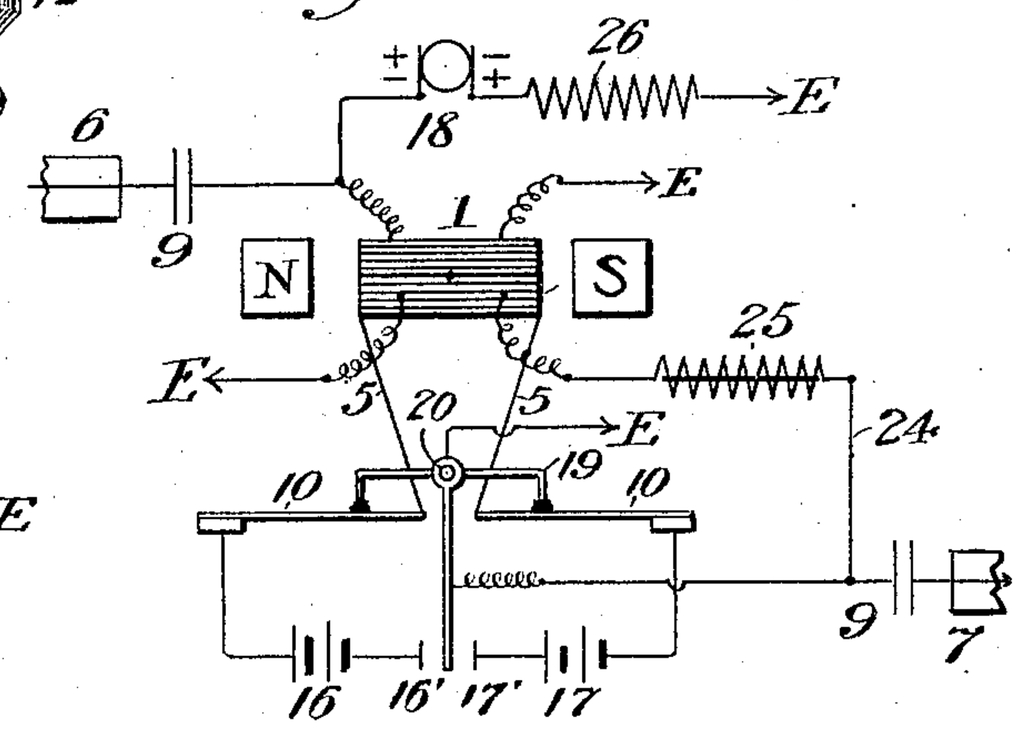


Fig. 10.

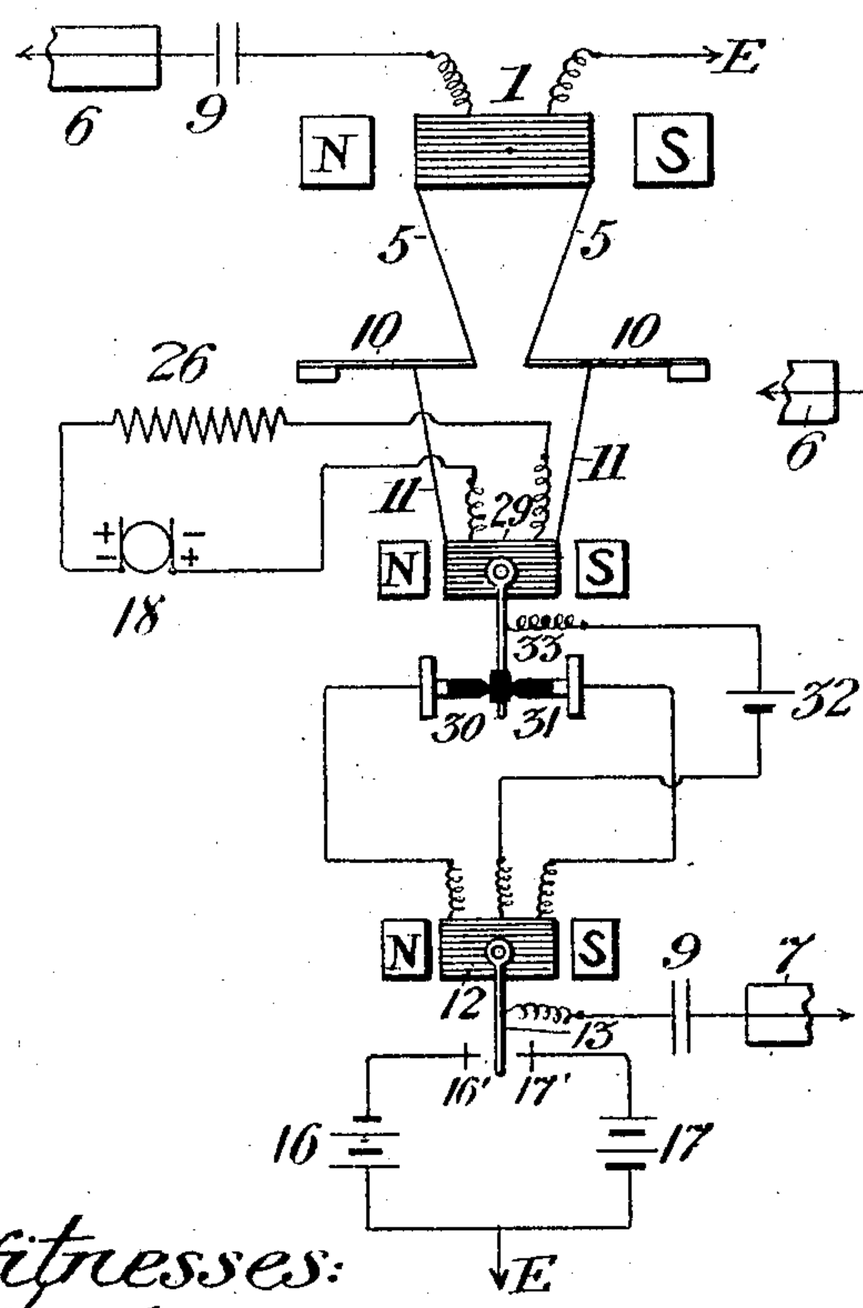
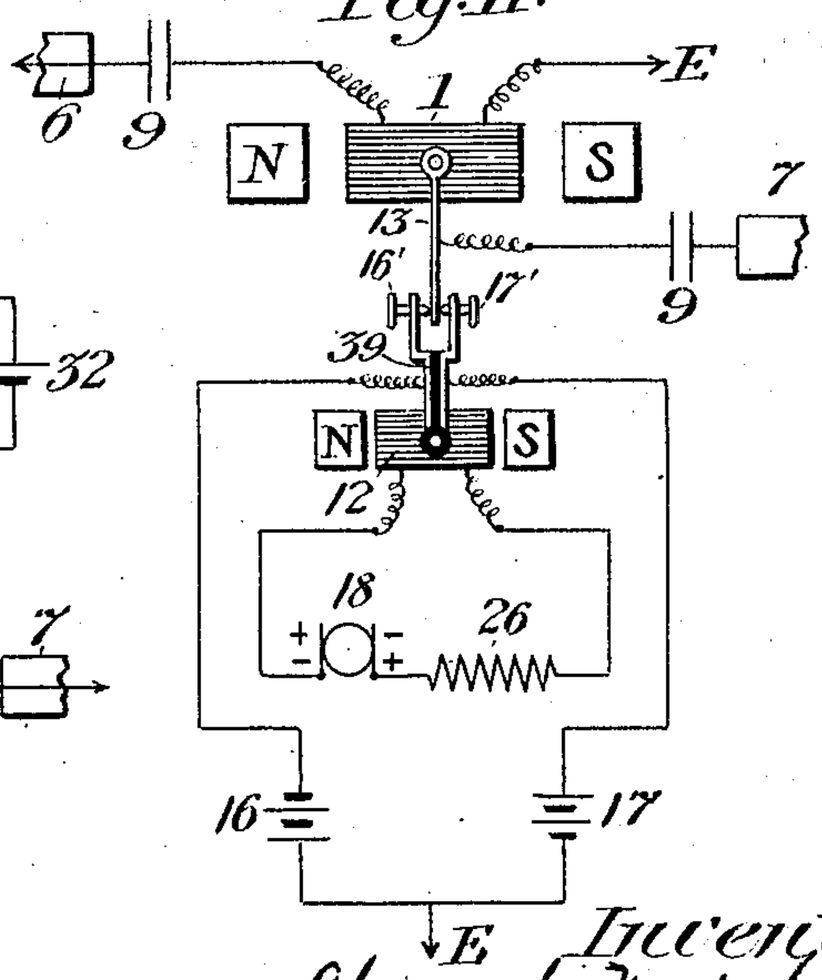


Fig. 11.



Witnesses:
E. B. Brunning
E. B. Burner

Inventor:
Alexander Muirhead
by his Attorneys
Baldwin Davidson & Wright.

No. 796,595. PATENTED AUG. 8, 1905.

A. MUIRHEAD.

TELEGRAPHIC TRANSMITTER.

APPLICATION FILED APR. 27, 1899.

3 SHEETS—SHEET 2.

Fig: 3

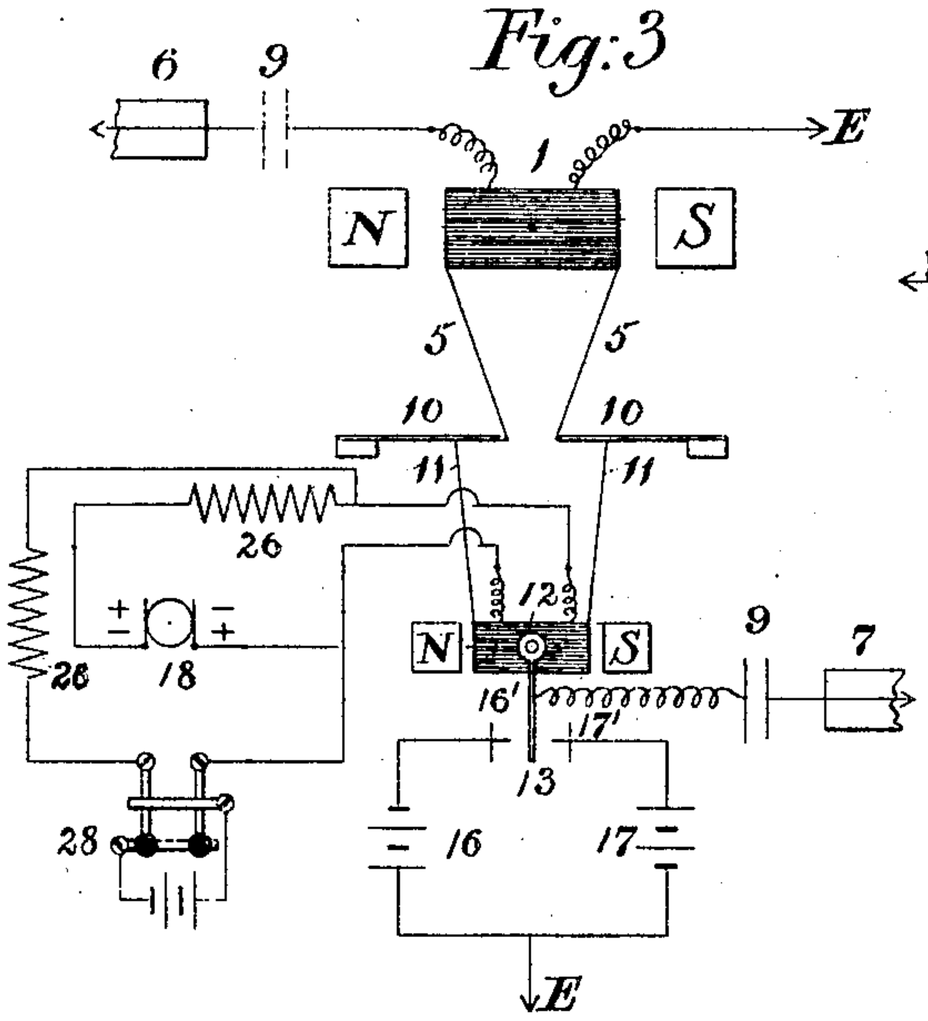


Fig: 4.

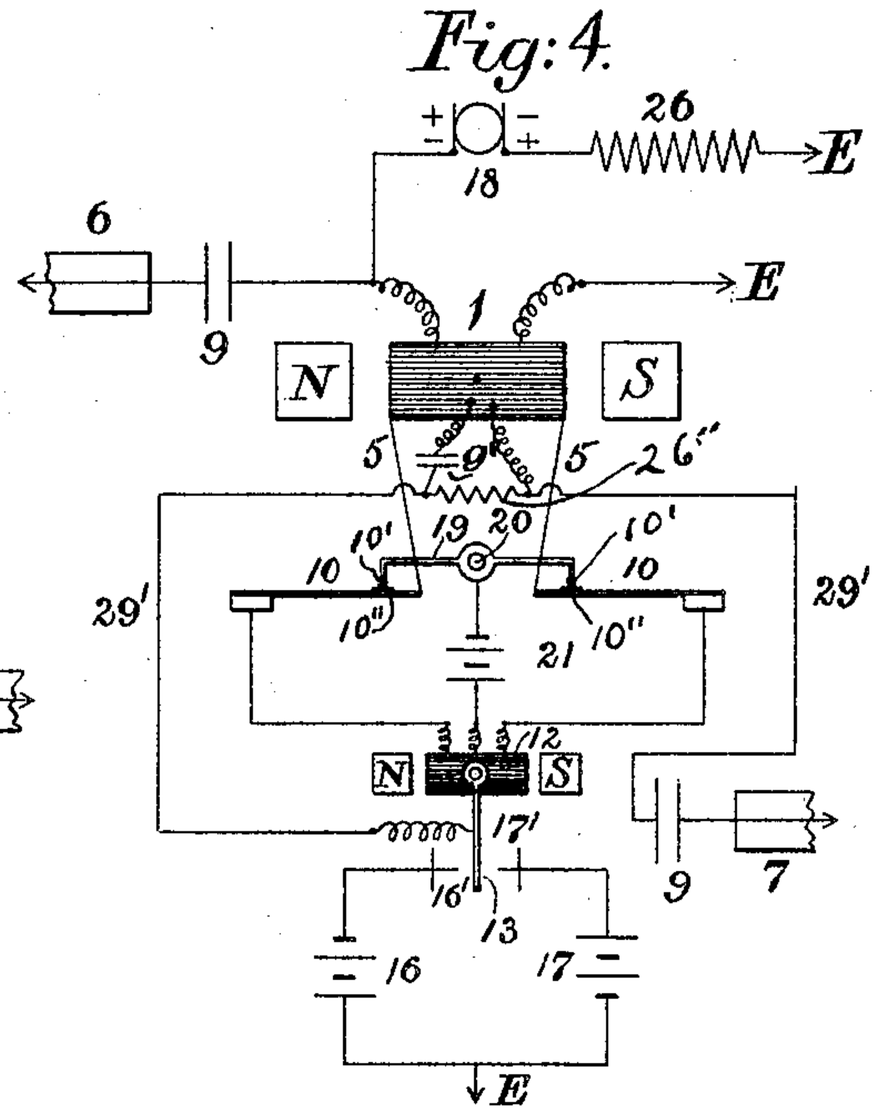
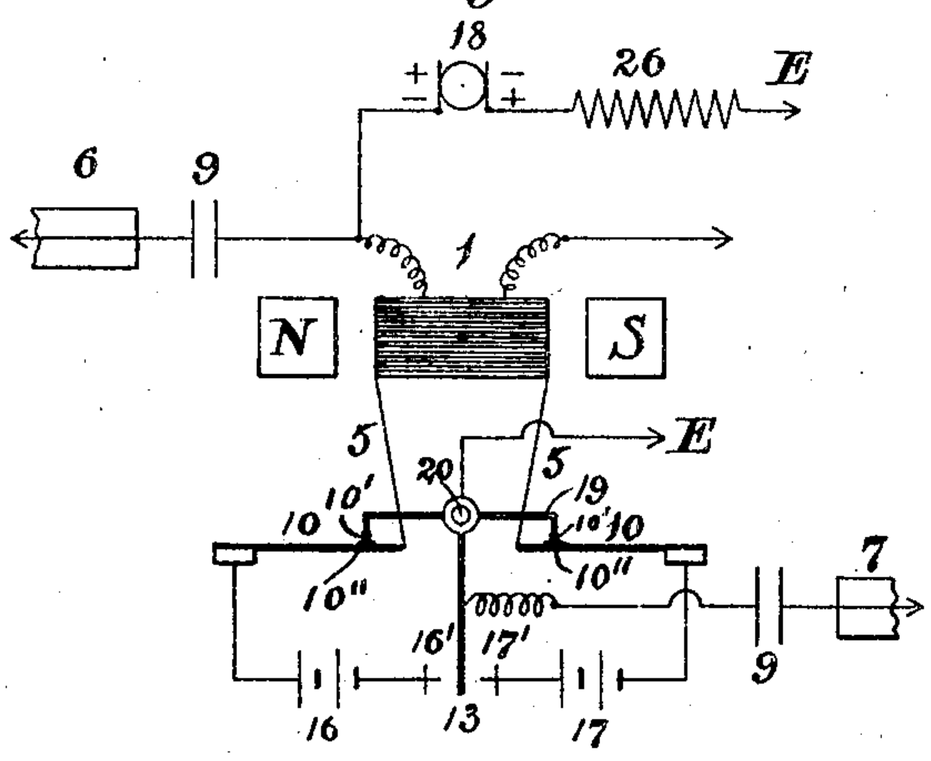


Fig: 5



Witnesses:
E. A. Bullock.
Walter Reed Tibbs.

Inventor
Alexander Muirhead.
By his Attorneys
Dodwin, Davidson & Wright.

No. 796,595. PATENTED AUG. 8, 1905.

A. MUIRHEAD.

TELEGRAPHIC TRANSMITTER.

APPLICATION FILED APR. 27, 1899.

3 SHEETS—SHEET 3.

Fig. 6.

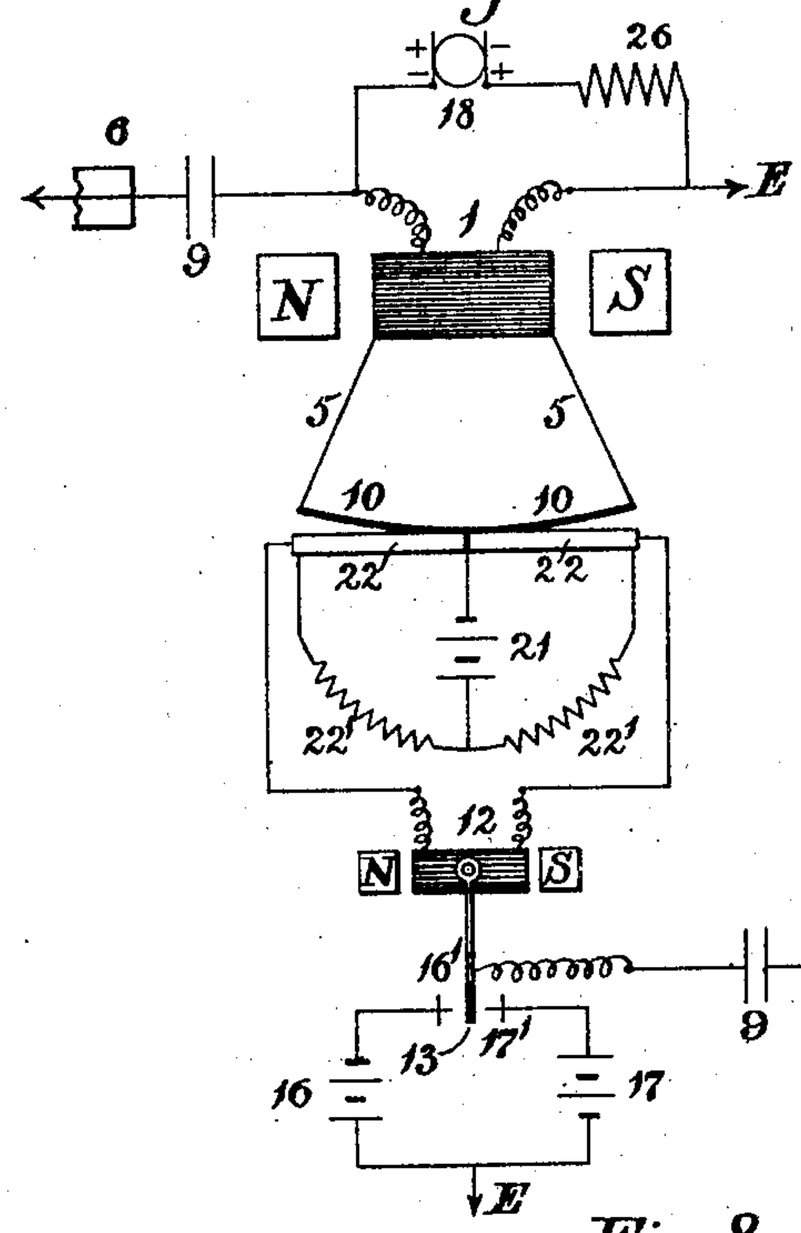


Fig. 7.

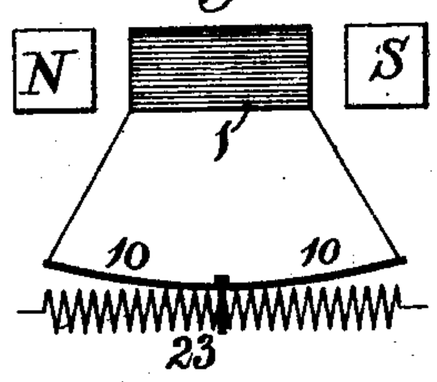
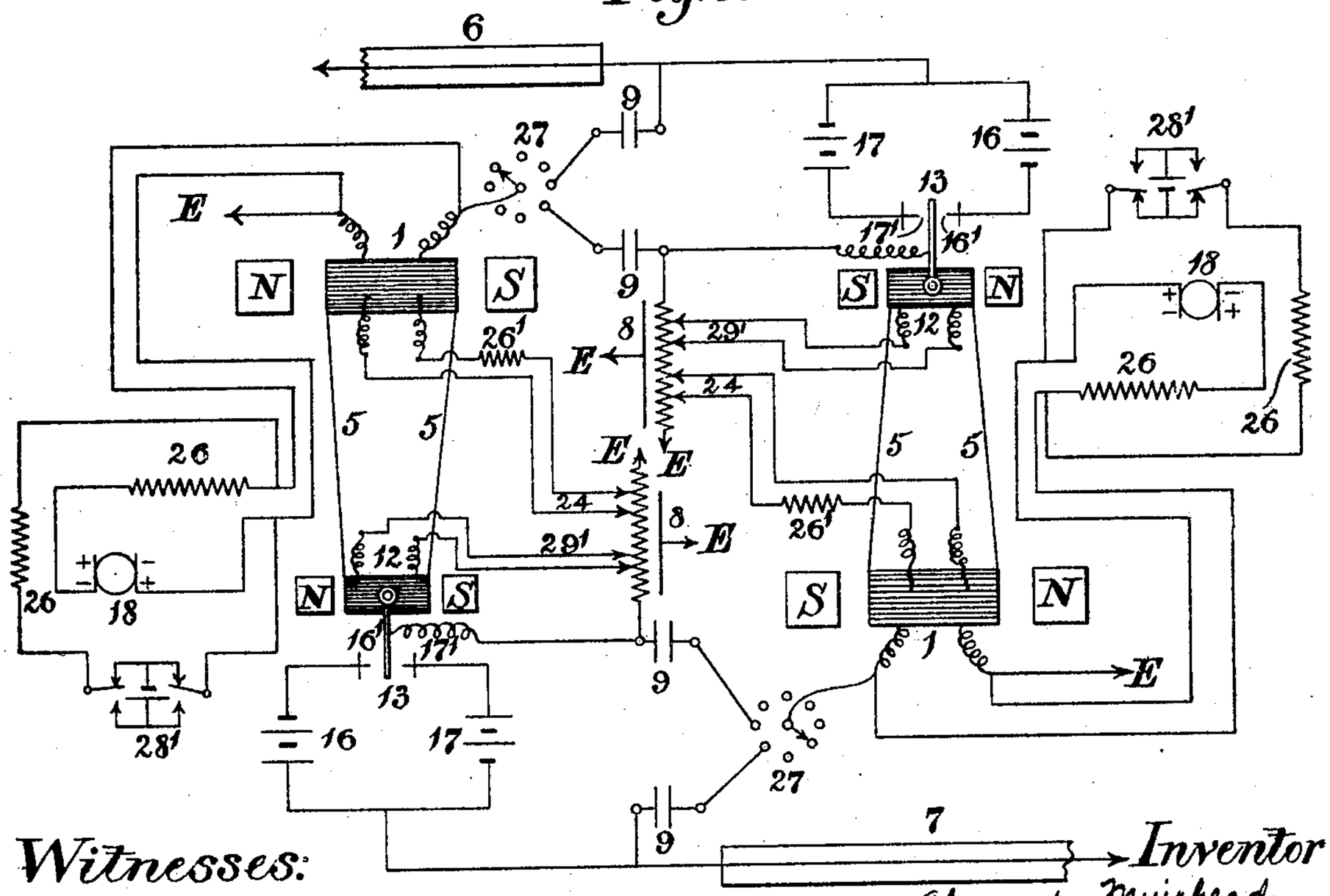


Fig. 8.



Witnesses:
A. M. Parkins.
S. B. Hollingsworth

Inventor
Alexander Muirhead,
by his Attorneys,
Baldwin Lawless & Wight

UNITED STATES PATENT OFFICE.

ALEXANDER MUIRHEAD, OF SHORTLANDS, ENGLAND.

TELEGRAPHIC TRANSMITTER.

No. 796,595. Specification of Letters Patent. Patented Aug. 8, 1905.

Application filed April 27, 1899. Serial No. 714,696.

To all whom it may concern:

Be it known that I, ALEXANDER MUIRHEAD, a subject of the Queen of Great Britain, residing at Shortlands, in the county of Kent, England, have invented certain new and useful Improvements in Telegraphic Transmitting, Receiving, and Translating Arrangements, of which the following is a specification.

My invention relates to the transmission, reception, and translation or retransmission of telegraphic signals.

It has for its objects to provide means for retransmitting signals received from one circuit onto another circuit in such manner that local transmitters can, if desired, be dispensed with and the apparatus thereby simplified; to provide means for preserving the "zero" of the organization and to improve the character of the local contacts; to provide means for automatically "curbing" the movements of the signal-coil or some equivalent part of the receiving-circuit, whereby the character of the signals retransmitted is improved, and generally to effect the improvements hereinafter indicated.

Being more particularly applicable to submarine cable-circuits, I will describe my invention in connection therewith; but it is to be understood that such invention by obvious modifications can be applied to other electrical circuits.

In the accompanying drawings, Figure 1 shows in perspective that part of a siphon recording instrument designated the "suspension-piece" as now generally constructed. Fig. 2 is a similar view of a suspension-piece with my improvements added thereto. Fig. 3 depicts one set of apparatus and connections for retransmission at an intermediate cable-station, the two coils marked 1 and 12 being mechanically connected to each other and the latter one receiving rapid alternations from the alternator 18, and a hand signaling-key 28 for initial transmission, while all impulses, whether initial or retransmitted, flow from the split line-battery 16 17 direct into the next section of cable 7. Fig. 4 depicts a similar arrangement, but with electrical instead of mechanical connection between the coils 1 and 12, the former one receiving the rapid alternations, while outflowing impulses are conducted through a special circuit of coil 1 on their way to the cable 7 for the purpose of increasing the firmness of the contacts. Fig. 5 depicts a simpler arrangement and whereby the second coil 12 is dispensed with. Fig. 6 illustrates a differential or Wheatstone bridge arrangement for communicating the effect of the movements of the coil 1 to the coil 12. Fig. 7 is a modification of part of the arrangement shown in Fig. 6. Fig. 8 illustrates the adaptation of my invention to cables that are "duplexed," an automatic transmitter 28′ being substituted for the hand signaling-key 28 of Fig. 3 and an "overflow" connection between the distant end of the artificial cable 8 and the coil 1 for the purpose of aiding the return of such coil. Fig. 9 depicts a similar overflow arrangement on a simplex circuit. Fig. 10 illustrates a means of increasing the firmness of the electrical contacts at the retransmitting-point. Fig. 11 illustrates an alternative method of mounting the contact-making devices to which vibration is imparted continuously.

Signals sent through submarine cables are generally received on the well-known Kelvin siphon recording instrument. The suspension-piece of this instrument comprises a signal-coil 1, suspended between the poles of a permanent or other suitable magnet (not shown) and an ink-siphon 2, carried by a cradle 3, which is supported by the stretched phosphor-bronze strip or wire 4 4. Extending between the signal-coil 1 and the cradle 3 are the two fibers 5 5, which, together with the stretched strip or wire 4 4 and the fibers supporting the signal-coil 1, form the mechanism which gives directive force to the said signal-coil. The normal or zero position of the coil 1 between the poles of the magnet N S is that indicated in the diagrams; but in practice when the coil is joined to a cable-circuit the mean position of the coil is constantly changing during signaling and is also liable to change from the influence of earth-currents.

My present invention comprises the utilization of the whole or a portion of the means which imparts directive force to the recorder-coil or to that part of the receiving instrument which is actuated directly by the cable-current in order to effect the translation or retransmission of corresponding electrical impulses or signals into the second line or cable, the increasing of the sensitiveness and the preservation of the zero of the apparatus by imparting vibration to the signal-coil or some equivalent part, and so causing the tongue that is included in the retransmission-circuit to vibrate against the battery-terminals, the strengthening of the battery-contacts through

the influence of the retransmitting-current, and the curbing—that is, hastening the return—of the parts under the same influence.

The arrangement can be attached to any existing siphon recorder, or if a record of the signals passing through from one section of cable to another is not required manifestly the ink-siphon and its appurtenances can be dispensed with and the suspension-piece modified in the manner substantially as shown in Fig. 2.

In all the applicable diagrams, 6 represents the cable from which, for the purpose of this description, it is assumed signals are about to be received, and 7 the one into which corresponding signals are to be retransmitted. 8 (see Fig. 8) is the artificial cable required for the purpose of duplex working. 9 9 represent the condensers, which are usually placed between the cable and the receiving or sending apparatus, and E E represent the earth connections. It will be understood that the connections in the case of simplex working may be changed over so that the cable 7 is connected to the coil 1 and the cable 6 to the tongue 13, or, alternatively, the apparatus between each section of cable may be duplicated for the same purpose. In the case of duplex working the apparatus must be so duplicated as shown in Fig. 8. When the two sections of cable at intermediate stations are duplexed and the two sets of apparatus are joined up according to this invention, transmission can take place automatically whether on "duplex" or "simplex" working.

I will first describe the nature of my improvements so far as they are included in Figs. 2 and 3. Two fibers 5 5 extend from opposite corners of the coil 1 to two suitable elastic phosphor-bronze or other metallic strips 10 10. Two other fibers 11 11 (similar to those marked 5) extend to a second coil 12, (similar to the coil 1 and located between the poles of a second magnet,) which may either be suspended in the same manner as the coil 1 or be pivotally mounted, as shown in Fig. 2. Supported on the second coil 12 and independently mounted either on the same axis or on an independent axis is a well-insulated tongue 13, whose freedom of movement on its support relatively to the said coil is regulated by a pressure-spring 14 (see Fig. 2) and screw-head 15 or like device. The tongue 13 plays between the terminals 16′ 17′ of a split battery 16 17 and is in electrical connection with the cable 7. Whenever an impulse from the cable 6 actuates the coil 1, the resultant movement is communicated either directly or indirectly to the coil 12 and the tongue 13 applied to one or other of the battery-terminals 16′ 17′, whereupon a corresponding impulse is sent into the cable 7.

It is essential to my invention that a constant tremor or vibration be imparted to the local contacting device either directly by vibrating such device itself or indirectly by vibrating one or other of the coils or any other base on which the said contacting device is mounted and frictionally held irrespective of the movements of the signal-coil brought about by the currents from the cable. I accordingly join up one or other of the said coils or some other suitable part of the organization to the circuit of an alternator 18. The constant vibration of either of the said recorder-coils (in the case of Fig. 3 it is the one marked 12) causes the tongue 13 to come successively into contact with the battery-terminals 16′ and 17′; but such contacts with the battery are made too rapidly to affect the receiving instrument at the distant end of the cable 7. The result of this rapid vibration of the tongue 13 against the battery-terminals 16′ and 17′ is to cause it to vary its position relatively to the coil or support upon which it is mounted and to maintain a mean position between the said battery-terminals whatever may be the movements of the coil or support to which it is attached and however the zero position of the signal-coil may vary. Upon a signal arriving from cable 6 the coil 1, and through it the support of the tongue 13, will while vibrating be deflected, putting the tongue 13, carried by it, into more or less effective contact with one or other of the battery-terminals 16′ or 17′, and so transmitting an impulse in one or the other direction into the cable 7, as already described. It will be understood that the fibers 5 and 11 are taut, being in tension against the flexure of the metallic directive strips 10.

In the arrangement depicted in Fig. 3 it will be observed that the movements of the coil 1 occasioned by the currents from the cable 6 are transmitted by the taut fibers 5 and 11 and the flexible strips 10 to the second coil 12, which second coil is constantly being vibrated by the alternating current of the alternator 18. In Fig. 4 a modification of this arrangement is shown in which the coil 1 is subjected to the influence of the alternator 18 and its tremors transmitted to the flexible metallic strips 10. These metallic strips vibrate against the extremities of a light cross-bar 19, of aluminium or other suitable material, pivotally mounted in a manner similar to the tongue 13, at the point 20. A local battery 21 is joined up to the second coil 12 (in this case differentially wound) and its circuit completed through the said cross-bar 19 and the flexible strips 10. The advantage of this arrangement, in comparison with that described with reference to Fig. 3, is that the current from the cable 6 is only called upon to actuate the coil 1 and its immediate connections and not to overcome the inertia of the second coil 12 and its tongue 13. By mounting pieces of well-polished graphite 10′ 10″ on the cross-bar 19 and the directive springs 10 10, respectively, at the points

where they come into contact a greater variation is produced in the circuit of the coil 12, especially when the signal-coil 1 is limited in its movements by being subjected to a strong controlling force. A still simpler arrangement is that depicted in Fig. 5, where the second coil is dispensed with and the tongue 13 is mounted, as already described, upon the same axis as the cross-bar 19 (and insulated therefrom) instead of upon the second coil. In this case the two flexible strips 10 are connected to the two opposite poles of the split line-battery 16 17, the cross-bar 19 is connected to earth, and the tongue 13 to line, as before.

Another means of communicating the effect of the cable-currents to the vibrating tongue 13 and in a magnified manner is to introduce between the coil 1 and the circuit of the coil 12 a variable resistance as part of a differential or Wheatstone bridge arrangement, as shown in Fig. 6, and to cause the elastic metallic strip 10 (which is kept in constant vibration, as before) to come into contact more or less, in accordance with the movements of the coil 1, with the surface of a conducting mass 22 (made, preferably, of a mixture of carbon and kaolin) on either side of the point at which the strip 10 is fixed, or, as shown in Fig. 7, a suitable spiral 23 of very fine closely-wound platinum silver or manganin alloy wire supported on a cylinder of ivory or other insulating material may be substituted for the rod of carbon 22, the lapping upon which spiral of the vibrating elastic strip 10 short-circuits a greater or less number of its helices on one side or other of the middle of the strip 10, thus upsetting the balance of the Wheatstone bridge composed of the two halves of the mass 22 or spiral 23 on either side of the center of the strip 10 and the two resistances 22′ 22′ and actuating the coil 12, which is included in the arrangement.

Fig. 8 shows a complete duplex installation on the well-known Muirhead "double-block" plan, such as that of my United States Patents No. 234,490, dated November 16, 1880, and No. 435,851, dated September 2, 1890, with my present invention in one form added thereto. In this figure, 24 24 depict two connections with the artificial cable which I have called the overflow, and 29′ 29′ are outflow connections, which are hereinafter more fully referred to. 27 27 are the usual low-resistance rheostats employed in connection with the block-condensers 9 9 in duplex working. When a current arrives from cable 6, it passes through the signal-coil 1, and thereby deflects the tongue 13 of the associated coil 12. A corresponding current is thereupon retransmitted into cable 7 from the split battery 16 17, between the poles of which the tongue 13 vibrates. Similarly when a current arrives from cable 7 it passes through the corresponding signal-coil 1, deflecting the tongue 13 of the associated coil 12, and thus a corresponding current is retransmitted into the cable 6. The cables 6 and 7 both being connected to artificial lines 8 8, as usual in duplex installations, transmission can take place automatically between the two cable-sections 6 and 7 either simultaneously or in alternate directions.

In cases where the cables are duplexed I may, as shown in Fig. 8, produce a curbing effect upon the movements of the signal-coil 1 or other portion of the arrangement which is actuated by the cable-current by connecting such coil or its equivalent through an overflow wire or connection 24 through a resistance 26′ between a separate circuit on each said coil and two suitable points at the far end of the artificial cable 8. The current that produces the curbing effect is part of that from the transmitting line-batteries 16 17 that passes into the artificial cable by way of the contact-points 16′ 17′ and tongue 13, there being a shunt from the artificial cable consisting of the overflow-wires 24, connecting with the cable through a resistance, the curbing-current being thus carried to the coil actuated by the cable-current. By this means a current in the reverse direction to that which had last actuated the mechanism is sent at the proper time and of correct strength through such coil, thus curbing or hastening the return of the coil to the zero position after the reception and retransmission of each signal. Instead of the artificial line an equivalent circuit made up of one or more self-inductance coils 25 may be substituted, as shown in Fig. 9.

26 26 represent resistances inserted for the purpose of regulating the strength of the current flowing in the various circuits.

A hand signaling-key or an automatic transmitter may be included in the system with each organization as a means of communicating from the intermediate station to either of the distant stations. The combination of a transmitter with a constantly-vibrating coil and a suitably-mounted tongue 13 vibrating between the battery-terminals 16′ 17′ would constitute a very effective arrangement for signaling on duplexed cables apart from the idea of retransmission from one section of cable to another. In Figs. 3 and 8 I have shown this combination, 28 in Fig. 3 indicating a hand signaling-key, and 28′ in Fig. 8 an automatic transmitter.

Fig. 3, for the sake of clearness, shows only the connection and apparatus for receiving from cable 6 and retransmitting into cable 7; but obviously, either by a switch or by duplication of the parts, messages may be sent in the opposite direction, as clearly indicated in other figures.

In order to assist the making of firm contacts between the transmitting contact-making device and the terminals 16′ and 17′ of the battery 16 17, which is very essential to ef-

ficient working, I may wind an extra circuit of very few turns on one of the coils 1 or 12 (the diagrams show it in connection with the coil 12) and insert the same between the tongue 13 and the cable 7, so that all outgoing currents from the battery 16 17 pass in the direction to achieve the object in view. This arrangement, termed the "outflow," is illustrated in Fig. 4, wherein the circuit may be traced from the battery 16 17, through the connections 29′ and the coil 1, to the cable 7. In the arrangement shown in Fig. 4 a condenser 9′ is placed in series with the extra circuit on coil 1, and both the condenser and extra circuit are shunted by a suitable resistance 26″ to permit just the necessary amount of the outgoing current to pass through the extra circuit to accomplish the desired result, or the outflow-circuit may be connected at two suitable points on the conductor of the artificial cable near to the beginning of the latter in the manner shown at 29′ 29′ in Fig. 8. A portion of the outgoing current which passes from the battery 16 17 into the second cable and also into the corresponding artificial line is thus diverted through the extra circuit of the signal-coil or the second coil in the direction to assist in making the contacts with the line-battery firmer. For the same purpose—that is, to insure the making of firm contacts between the relay-tongue and battery-terminals—I may employ the arrangement illustrated by Fig. 10, in which a third coil 29 is inserted between the coil 12 (in this case differentially wound) and the coil 1. The contact-stops 30 31 in this arrangement are preferably made of well-polished graphite, and the tongue 33 is tipped with the same material where it comes into contact with the stops 30 31. The tongue 33, through the stops 30 31 and the two circuits of the differentially-wound coil 12 of suitable resistance, forms a complete differential circuit with a suitable battery 32. The tongue 13 of the second coil 12 plays between the terminals 16′ 17′ of the split line-battery 16 17, as in the other figures. On the passage of a current from the cable 6 through the coil 1 the coil 29 is deflected in one direction or the other and pressure brought to bear upon the corresponding contact-stop 30 or 31. The effect of the variation of pressure on these contact-stops is to cause a corresponding varying current to flow through the second coil 12, which actuates the tongue 13 in one direction or the other against the terminals 16′ 17′ of the retransmitting-battery 16 17. Obviously, also, instead of causing a pivotally-mounted tongue to vibrate between stationary terminals as a contacting device I may, as indicated in Fig. 11, similarly mount an arm 39, carrying the terminals 16′ 17′ of the split battery 16 17, upon the second coil 12 or other supporting-body and fix the contact-tongue 13 upon the signal-coil 1, or, further, I might fix the arm 39 on the coil 12 and pivotally mount the tongue 13 upon the signal-coil 1, as before.

In some cases I may dispense with the elastic strips 10 and directly connect the two coils 1 and 12 by the two fibers 5 5, as shown in Fig. 8.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. The combination, in the sending-circuit of a telegraph system, of an initial transmitter, a recorder-coil in the battery-circuit of such transmitter, a line-battery, and a loosely-mounted constantly-vibrating contacting device the plane of vibration of which coincides with the plane of oscillation.

2. The combination, in the sending-circuit of a telegraph system, of an initial transmitter, a recorder-coil, in the battery-circuit of such transmitter, a line-battery, a loosely-mounted local contacting device and means serving to constantly vibrate the latter in a plane coincident to that of its oscillation.

3. In a telegraphic receiving and translating arrangement, the combination, with a receiver an attached contacting device and a retransmitting line-battery, of means serving to impart constant vibration to the cable-current-actuated part of the receiver in a plane coincident to that of its oscillation whereby said contacting device is maintained in correct position relatively to the part on which it is frictionally mounted and to the terminals of the retransmitting line-battery.

4. In a telegraphic receiving and translating arrangement, the combination, with a receiver, an attached contacting device and a retransmitting line-battery, of an "overflow" connection between said retransmitting line-battery and the cable-current-actuated part of the receiver for the purpose of curbing said cable-current-actuated part.

5. In a telegraphic receiving and translating arrangement, the combination, with a receiver, and an attached contacting device, of an "overflow" connection between a battery and the cable-current-actuated part of the receiver for the purpose of curbing said cable-current-actuated part.

In testimony whereof I have hereunto subscribed my name.

ALEXANDER MUIRHEAD.

Witnesses:
A. F. SPOONER,
J. SUTTON.