(No Model.) 3 Sheets—Sheet 1.

C. ADER.

TELEGRAPHY.

No. 377,879. Patented Feb. 14, 1888.

Fig. 1

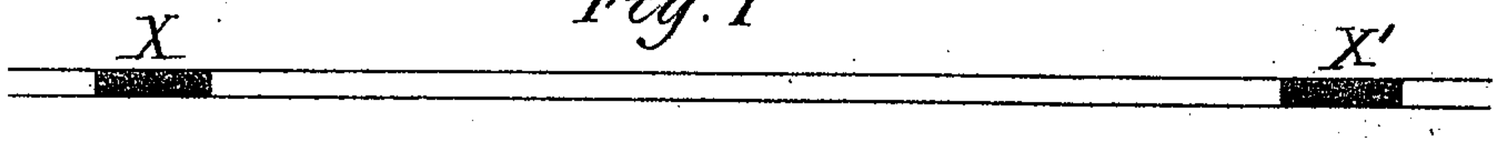


Fig. 2

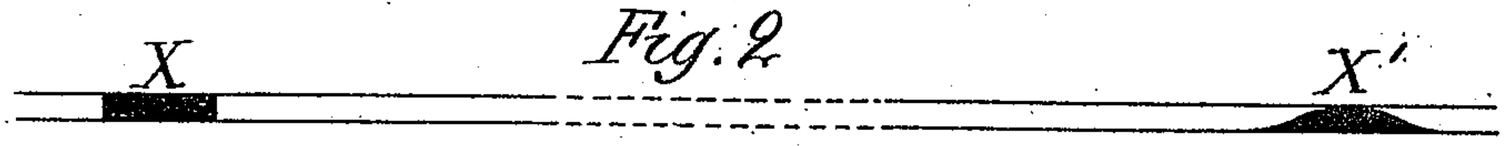


Fig. 3

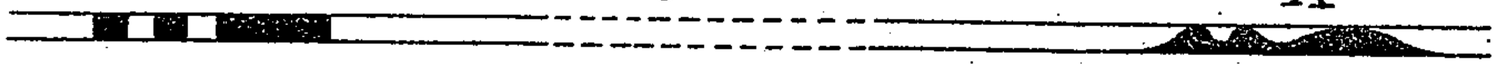


Fig. 4

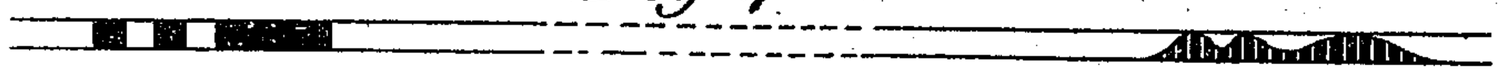
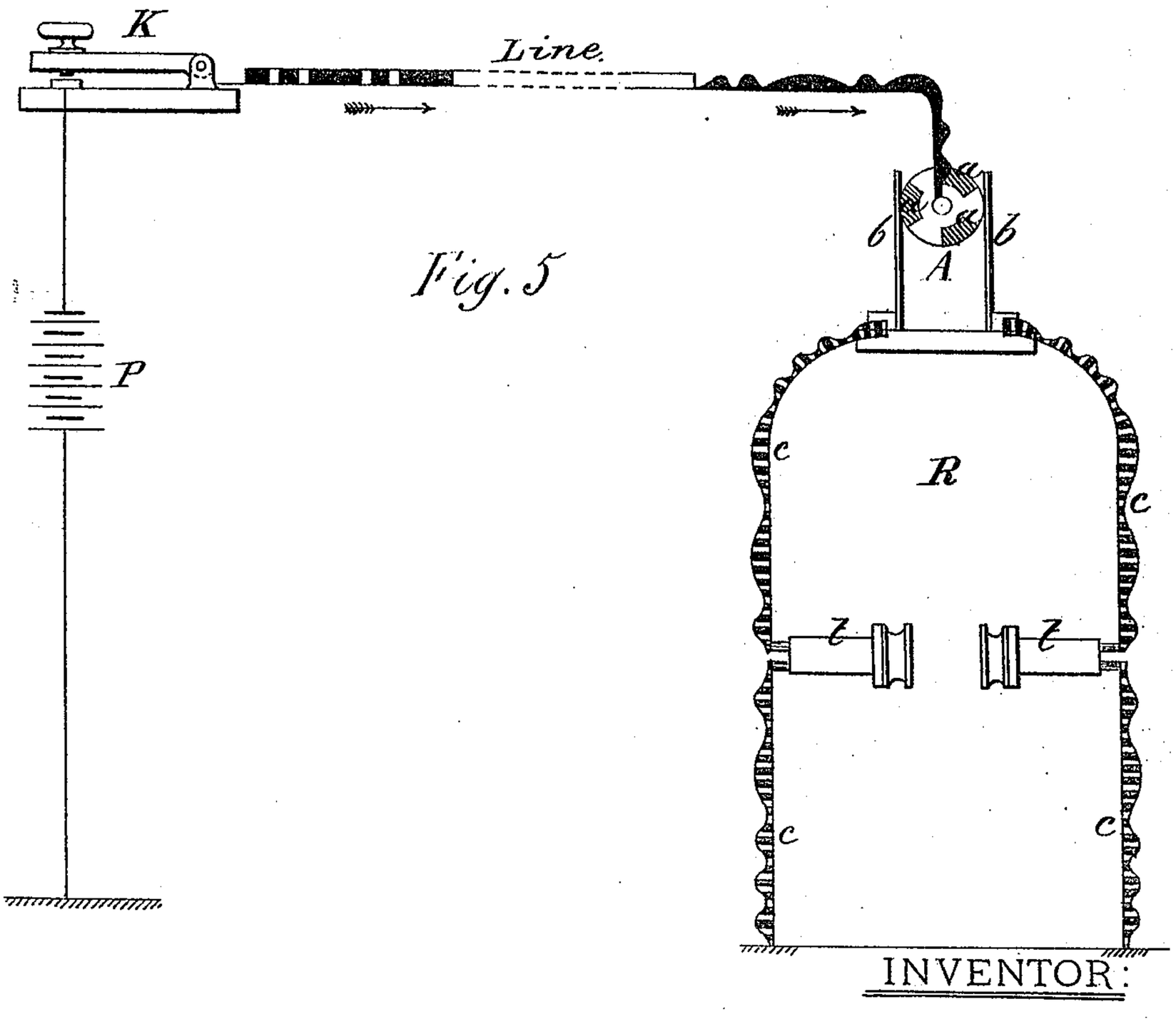


Fig. 5



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(No Model.) 3 Sheets—Sheet 2.

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TELEGRAPHY.

No. 377,879. Patented Feb. 14, 1888.

Fig. 6.

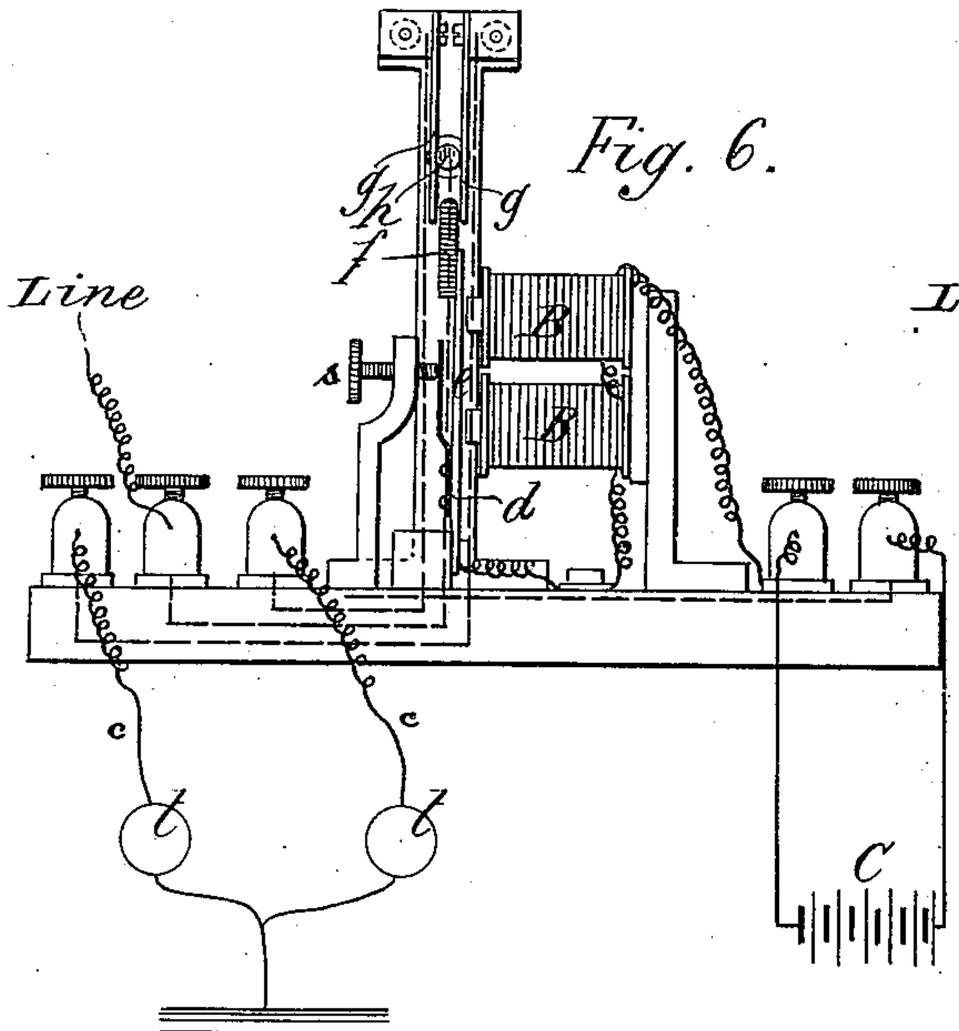


Fig. 7.

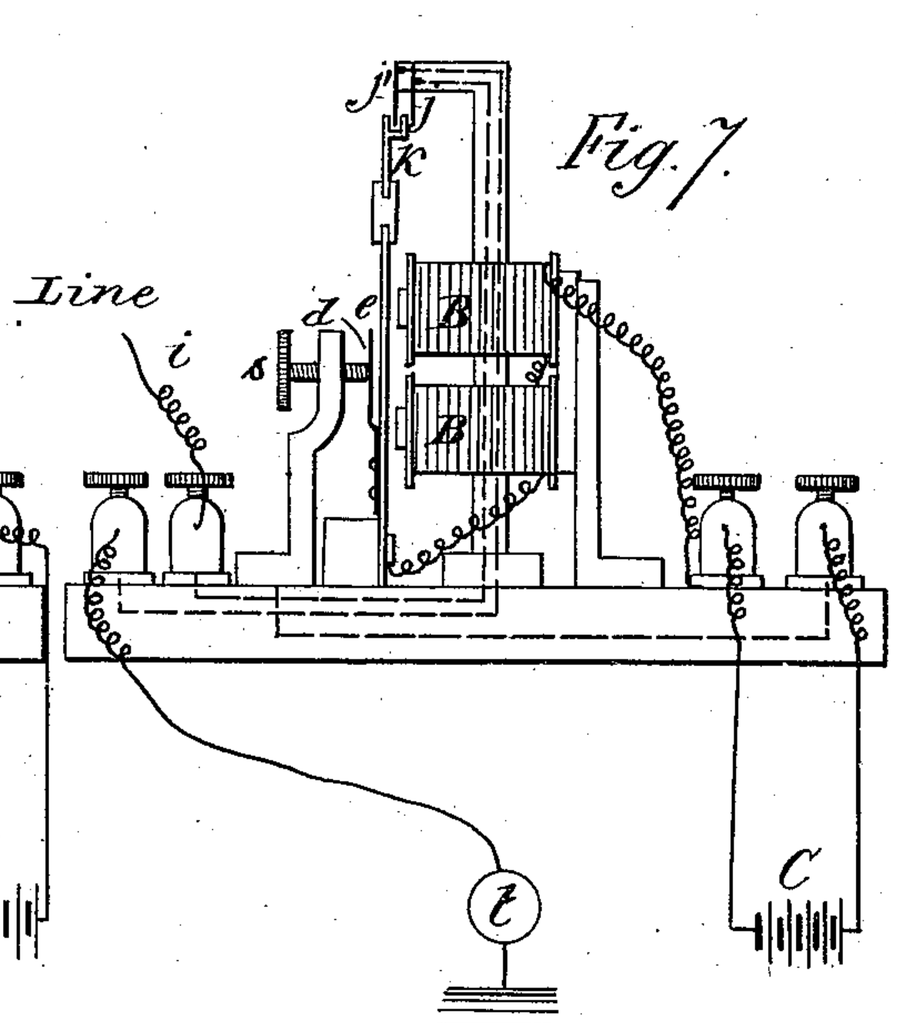


Fig. 8

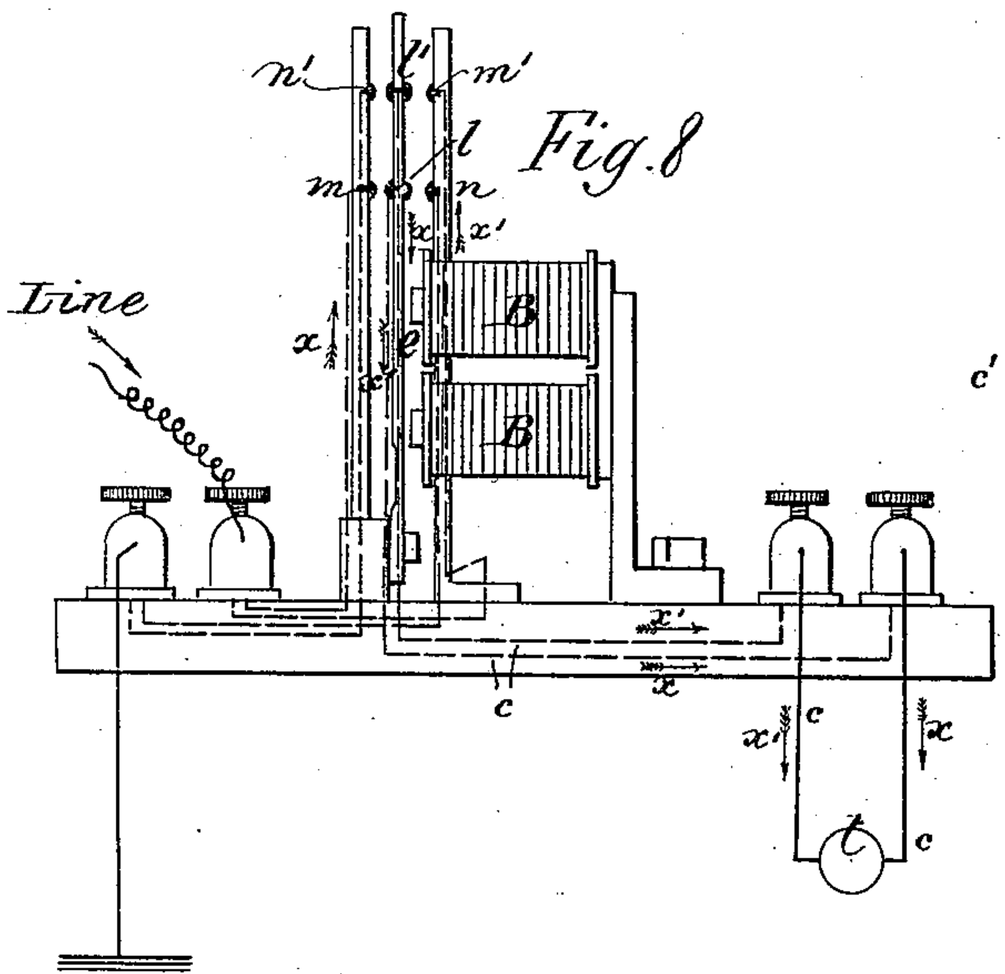
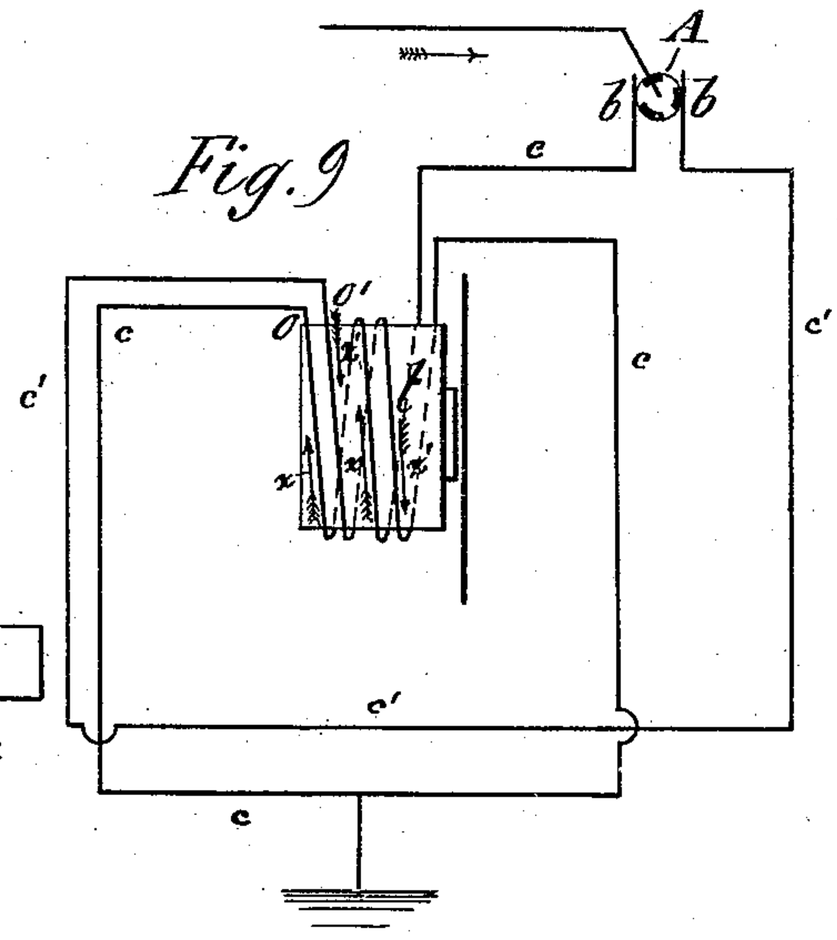


Fig. 9



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TELEGRAPHY.

No. 377,879. Patented Feb. 14, 1888.

Fig. 10

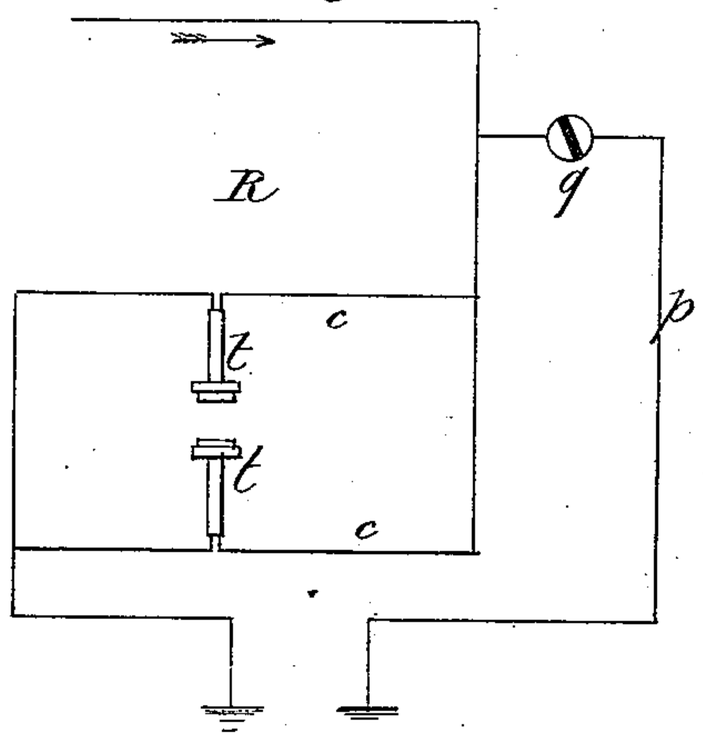


Fig. 13

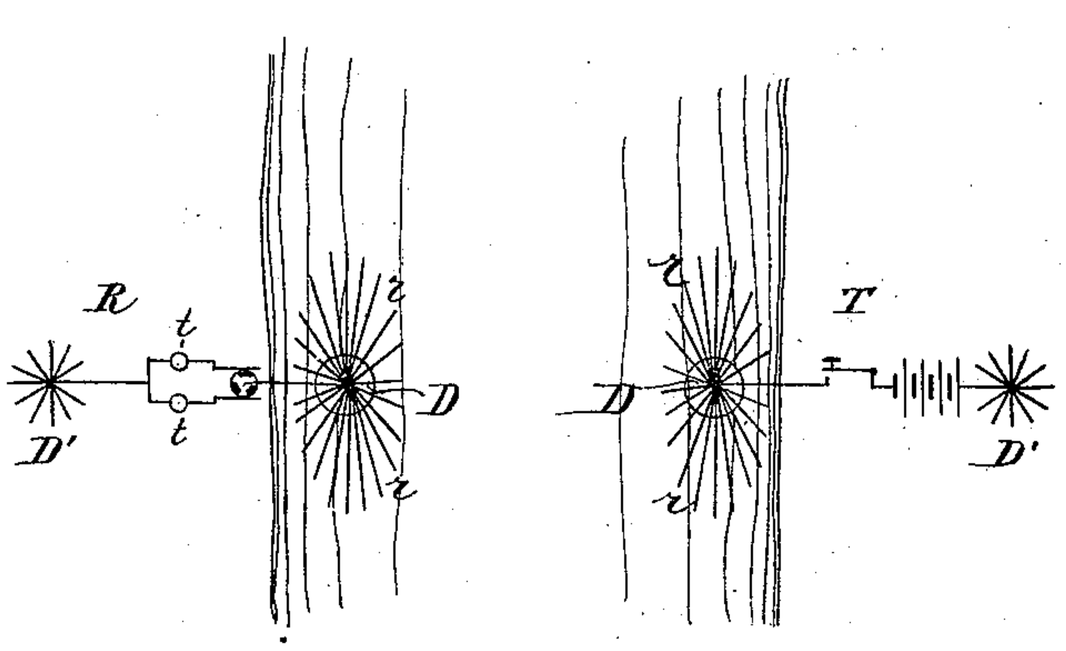


Fig. 11

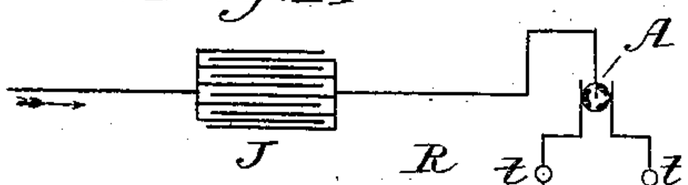


Fig. 14

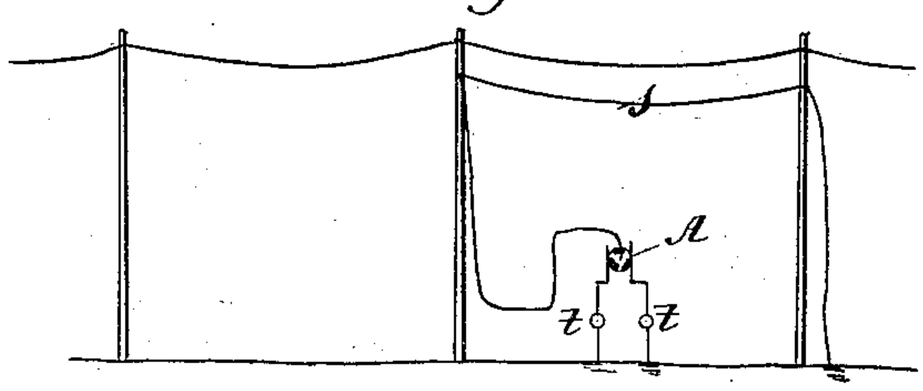


Fig. 12

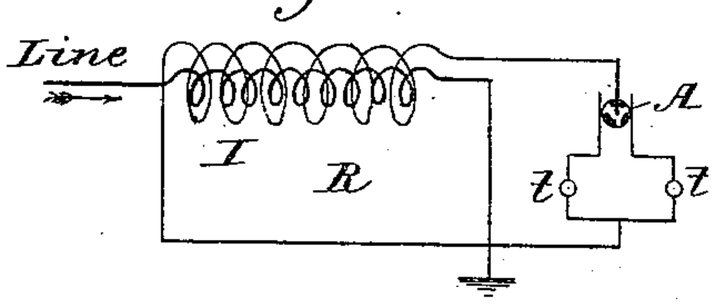


Fig. 15

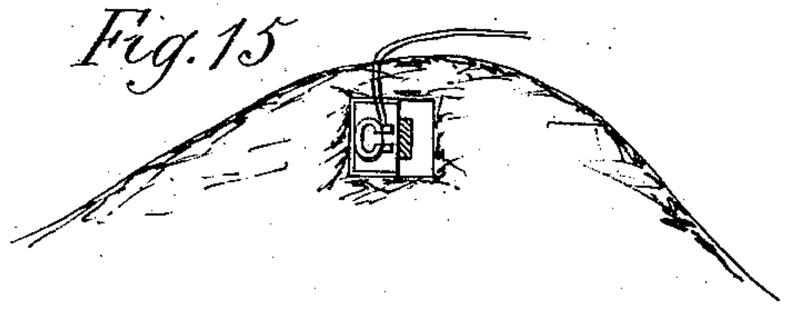


Fig. 17

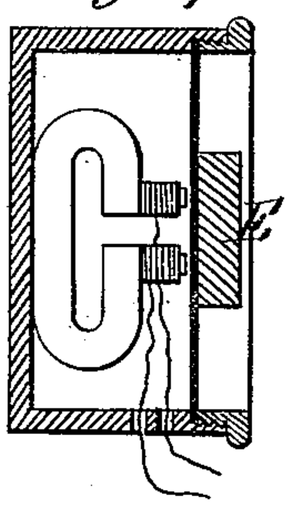


Fig. 18

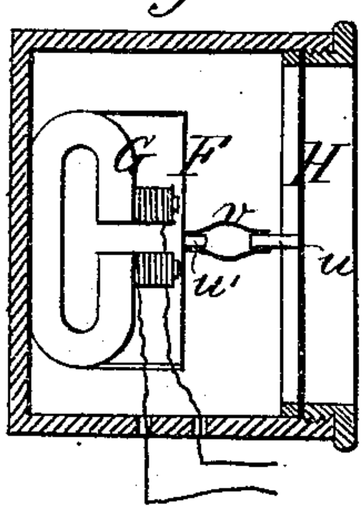
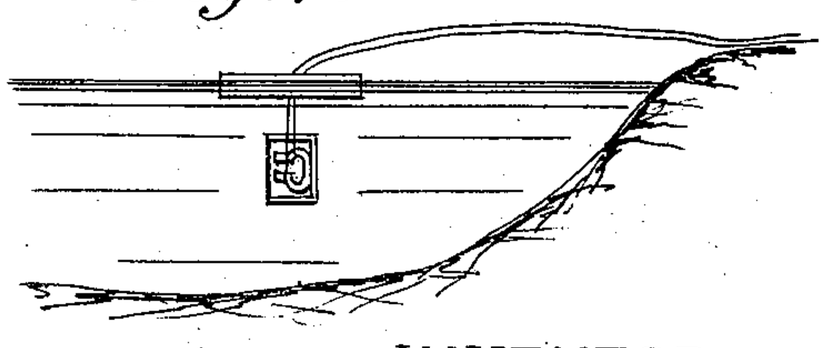


Fig. 16



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UNITED STATES PATENT OFFICE.

CLEMENT ADER, OF PARIS, FRANCE.

TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 377,879, dated February 14, 1888.

Application filed July 1, 1887. Serial No. 243,124. (No model.) Patented in England May 18, 1887, No. 7,265.

To all whom it may concern:

Be it known that I, CLEMENT ADER, a citizen of the French Republic, residing in Paris, France, have invented certain new and useful Improvements in the Art of and Means for Electric Signaling or Telegraphing, of which the following is a specification.

This invention has been patented in Great Britain by Patent No. 7,265, dated May 18, 1887.

This invention relates, principally, to the method of receiving telegraphic or other electric signals, whereby they are rendered audible.

I will proceed to explain the principle upon which my invention is based with reference to Figures 1, 2, 3, and 4 of the accompanying drawings, which are diagrams illustrating graphically the electric currents as transmitted and received over electric circuits.

Let us assume that intermittent currents are transmitted over an ordinary telegraphic circuit by means of the usual key. We may then represent the current emitted from the sending-station by a mark, X, in Fig. 1, of uniform thickness, and if the circuit is relatively short or presents but little resistance the intermittent currents arriving at the receiving-station will present substantially the same form, and may be represented by the mark X′ in Fig. 1. If, however, the line is long or presents a high resistance, the current undergoes a change of form during its transmission and reaches the receiving-station not as a series of sharply-defined pulsations, but as an undulatory current of varying intensity, such as may be represented by the undulatory mark X′ in Fig. 2. Thus, in telegraphic transmission according to the Morse alphabet, there is received at the receiving-station a series of undulatory pulsations of varying intensity and of different length, which may be represented by undulatory tracings, as shown at X′ in Fig. 3. This is the result of the ordinary method of telegraphic transmission over long circuits or those of high resistance. Much difficulty is continually experienced in the reception of messages thus transmitted, since a very accurate adjustment of the receiving-instrument is rendered necessary, and this adjustment must be varied from time to time to correspond with the varying conditions of the line. It is the object of my invention to provide a method of reception which shall avoid this difficulty.

It has been proposed to receive telegraphic signals by means of a receiving-telephone, the diaphragm of which should be vibrated in consonance with the variations in the intensity of the currents. This method is impracticable, for the reason that if the number of vibrations produced by the current is not such as to produce a sound or note perceptible to the ear the message cannot be read by listening in the telephonic receiver. My invention overcomes this difficulty by means which I will now describe.

Let us suppose that one intercalates in the circuit at the receiving-station and at a point traversed by the current before it reaches the telephonic receiver an apparatus which subdivides the undulatory current into pulsations succeeding one another regularly and continually and with great rapidity, as denoted in Fig. 4, their velocity being such that the number of pulsations per second corresponds to the number of vibrations necessary for producing a sound or note perceptible to the ear. The current thus subdivided being received in the telephone produces therein a continuous sound or note of uniform pitch; but as the currents which form the telegraphic signals are undulated the sound that is heard in the telephone is more or less loud or intense. This sound thus becomes an exact reproduction of the transmitted signals. It is possible in this manner to receive electric signals acoustically at great distances under the form of undulatory sounds. It is only necessary that the signals which arrive in the form of undulatory electric currents or impulses shall be subdivided into rapidly-successive pulsations, the number of which corresponds to an audible sound or note. Such is the principle of my invention, to which I have given the name of the "phono-signaling" system.

It will be understood that by means of this system the transmission of electric signals over long lines is rendered much more rapid than by those heretofore in use, since it is no longer necessary to discharge the line between the successive emissions of the signals.

The principle of my invention being thus understood, I will now proceed to describe the means which I have devised for practicing it.

In so doing I will make reference to the remaining figures of the accompanying drawings, of which—

Fig. 5 is a diagram illustrating a telegraphic circuit with sending and receiving stations, and representing the transmitted current before and after subdivision. Fig. 6 is a side elevation of one construction of instrument for effecting the subdivision of the current. Fig. 7 is a similar view of another construction of such instrument. Fig. 8 shows still another construction. Fig. 9 is a diagram of a modified construction of receiving-instrument, and illustrating the arrangement of the circuit at the receiving-station. Figs. 10, 11, and 12 are diagrams illustrating different circuit arrangements at the receiving-station. Fig. 13 is a diagram of a circuit for telegraphic transmission across bodies of water. Fig. 14 is an elevation of a portion of a telegraph-line, illustrating the application of my invention to the inductive reading of messages therefrom. Fig. 15 is a vertical section illustrating the utilization of my invention for the detection of subterranean disturbances. Fig. 16 is a similar view showing its utilization for the detection of submarine disturbances. Fig. 17 is a vertical transverse section of the transmitting-instrument employed for the detection of subterranean disturbances, and Fig. 18 is a similar view of the transmitting-instrument employed for submarine use.

Referring to Fig. 5, let T designate the transmitting and R the receiving station. At the former is the battery P and the transmitting-key K, both of which may be installed in the manner common to electric telegraphs. At the receiving-station are telephonic receiving-instruments *t t*, which may be ordinary magnetic telephones, and a commutator, A, which is installed between the receiving-telephones and the line. This commutator is the instrument by which the subdivision of the electric current is effected. In the construction here shown it consists of a rotary cylinder having blocks *a a*, of insulating material, set at intervals in its periphery and rotating between metal contact plates or springs *b b*, which touch it peripherally. The commutator is rotated continuously and at the requisite speed by any convenient local force independent of the current on the line. It may be, for example, a belt from shafting or an electromotor fed by a local battery. The arrangement of the insulating-blocks *a a* relatively to the contacts *b b* is such that the line is connected alternately with one contact or the other through the metallic portion of the cylinder, and when its metallic portion is touching one contact one of its insulations is against the other contact. Thus, as the commutator revolves, the current coming over the line is subdivided by bifurcation, and the successive pulsations pass alternatively into two branches, *c c*, of the circuit, both of which lead to the earth, and in each of which one of the telephonic receivers *t* is intercalated. Thus each telephone receives a series of pulsations succeeding one another with the velocity requisite for producing an audible note and occurring in alternation with the pulsations in the other telephone, as clearly indicated in the diagram by the undulatory lines. By this method of subdivision of the current by bifurcation the line-circuit is not interrupted, since it is continually connected to earth through either one branch *c* or the other.

Fig. 6 shows another method of subdividing the current by bifurcation. Instead of a rotary commutator, a vibratory one is here employed, being vibrated at a uniform velocity by an electro-magnet operating on the principle of the rheotome. The electro-magnet B is fed by a local battery, C, the circuit from which, after traversing the coils of the magnet, passes through a contact-spring, *d*, which comes against a screw, *s*, through which the current passes on its return to the battery. This constitutes the rheotome, the construction being such that when the magnet B attracts its armature *e* it draws the spring *d* out of contact with the screw *s* and breaks the circuit, whereupon the armature flies back by reason of its elasticity and re-establishes the contact. The armature *e* is thus given a constant and rapid vibration before the poles of the magnet. It carries at its end a finger, *f*, of insulating material, which vibrates between two very light springs, *g g*, and in its vibration displaces them alternately out of contact with a button, *h*, of conducting material, between them. The button *h* is connected to the line, and the springs *g g* are connected to the respective branches *c c* of the circuit, in which are intercalated the receiving-telephones *t t*.

The current may be subdivided by simply interrupting it, although I do not prefer this method. Fig. 7 shows a means for accomplishing its subdivision in this manner. The rheotomic magnet B, with its armature *e* and contacts *d s*, is of the same construction as in Fig. 6. The armature *e* carries at its free end a conducting-fork, *k*, which is insulated from it, and which on vibrating toward the magnet touches and electrically connects together two contact-springs, *j j'*, and on its vibration from the magnet passes out of contact therewith and breaks the circuit. The spring *j* is connected with the line-wire *i* and the spring *j'* is connected to earth, the receiving-telephone *t* being intercalated in the latter connection. The circuit is thus alternately closed and broken, the interruptions being of such velocity as to produce the requisite audible sound in the telephone.

The subdivision of the current may be accomplished by alternating its direction, causing it at the receiving-station to flow first in one direction and then in the other, and the alternations of direction succeeding each other with the frequency requisite for the production of an audible sound. For this purpose it is necessary to employ a current-alternating

commutator at the receiving-station. This commutator may be either rotary or vibratory, many different constructions of each kind being well known in the art. As an example of one construction that may be used, I would make reference to Fig. 8, which shows a vibratory commutator vibrated by a rheotomic magnet, B, as in Figs. 6 and 7. For the sake of clearness, the contacts and local battery pertaining to this rheotome are not shown. Its vibratory armature *e* carries two contact-buttons, *l* and *l'*, which are insulated from each other and constitute the opposite terminals of a loop or branch, *c*, of the circuit, in which loop the receiving-telephone *t* is intercalated. On one side of the armature are two contacts, *m* and *n'*, which are touched by the contacts *l* and *l'* when the armature recedes from its magnet, and on the opposite side are two contacts, *n* and *m'*, which are touched by the contacts on the armature when the latter approaches its magnet. The line-circuit is divided into two branches, one of which terminates at the contact *m* and the other of which terminates at the contact *m'*. The earth-wire is likewise divided into two branches, one of which terminates at the contact *n* and the other of which terminates at the contact *n'*. When the armature is retracted from its magnet, the current of the line enters at *m* and follows the path indicated by the arrows *x x*, flowing through the loop *c* and passing out at *n'* to the earth. On the opposite vibration of the armature the line-current enters at *m'* and passes through the loop in the direction indicated by the arrows *x' x'*, passing out at *n* to the earth. These alternations of direction of the current passing through the telephone produce the same effect as the subdivision by interruption or bifurcation.

The same result may be accomplished without the employment of a current-alternating commutator by the arrangement shown in Fig. 9. The magnet-core of the telephone *t* is here wound with two coils, which are intercalated, respectively, in the two branches *c* and *c'* of the circuit. The current is subdivided between these branches by bifurcation through the medium of the rotary commutator A, as first described, and the respective coils *o o'* are connected in inverse order in the two branches in such manner that when the current is passing through the branch *c* it flows around the telephone-coil in the direction denoted by the arrows *x x*, whereas when the current is flowing through the branch *c'* the current flows around the telephone-coil in the opposite direction, as denoted by the arrows *x' x'*. Thus the telephone is influenced by currents flowing in alternately opposite directions.

It is not necessary that the commutator for subdividing the current be arranged in the line-circuit, as it may be placed in a derivation thereof. Fig. 10 shows such an arrangement. The line-circuit is divided into two branches, *c c*, at the receiving-station, in each of which one of the receiving-telephones *t* is intercalated, and outside of these branches is a short circuit or shunt, *p*, in which is intercalated a current-interrupting commutator, *q*. When the shunt-circuit is broken by the commutator, the entire current passes for an instant through the telephones *t t*; but when the shunt is closed the greater portion of the current passes to earth through the shunt, thereby avoiding the telephones. This constitutes what I call "subdivision by derivation."

If necessary, condensers may be interposed in the circuit at the receiving-station, as is done with electric submarine cables. This is shown in Fig. 11, where J designates the condenser.

My system may be worked inductively, if desired, by providing an induction-coil at the receiving-station and passing the line-current through the primary wire thereof to the earth, while the secondary wire thereof is joined in a local circuit, which is provided with a current-subdividing commutator and with receiving-telephones. Fig. 12 shows such an installation, I being the induction-coil, A the commutator, and *t t* the telephones.

My "phono-signal" system is applicable not only to aerial telegraph-lines and submarine cables, but also for electric transmission along or across rivers, lakes, arms of the sea, and other bodies of water wherein the water constitutes the sole conductor in lieu of a line-wire. Fig. 13 illustrates such a circuit. In this case it is necessary to arrange in the water, both at the receiving and transmitting sides thereof, floats D D, provided with metallic conducting-rods *r r*, which spread out in all directions, in order to distribute the current to a very large surface of the liquid, so as to conduct the current to the latter and collect it therefrom with the least possible resistance and loss, whereby the liquid may be utilized as a conductor. At the transmitting side of the body of water is a short metallic circuit containing the battery and transmitting-key, and at the receiving side is another short circuit containing the commutator A and the telephones. Both these circuits terminate in earth-connections, which are by preference made through the medium of plates D' D', which radiate in all directions. In this case it is preferable to arrange at the receiving-station condensers or induction-coils, as above described.

Fig. 14 shows an application of my new system for the purpose of reading the signals transmitted over a telegraph-wire without interrupting their transmission to their destination. For this purpose a wire, *s'*, is strung between two telegraph-poles parallel with and in proximity to the line-wire, in order that upon the passage of currents over the latter these currents, which are either intermittent or more or less undulatory, shall induce corresponding currents in the wire *s'*, and these induced currents are read by means of telephones *t t*, between which the current is subdivided by a commutator, A, as already described. Finally,

this system enables slow oscillations or vibrations, as in the case of subterranean noises, earth-tremblings, and noises made under water by steamboats or torpedo explosions and the like, to be detected. These noises or concussions are transmitted by means of a battery or magnetic telephone. My system is applicable for the reception of signals of similar character where undulatory currents are sent over the line emanating from electric transmitters. It is necessary in such case to construct the transmitter appropriately to the special use for which it is destined.

Fig. 15 illustrates the arrangement of a transmitter for the observation of subterranean sounds or concussions. For this purpose the transmitting-instrument is buried in the earth at a suitable depth, and should be of such construction as to be sensitive to the slow vibrations which it is to transmit. Fig. 17 shows its preferred construction. It consists simply of a magnetic telephone the vibrating diaphragm of which carries a weight, E, which increases its inertia. If the soil is subjected to vibratory movements, the transmitter is displaced with it; but the diaphragm, tending to remain in place by reason of its inertia, is not moved so quickly as the electro-magnet, so that they mutually recede from and approach each other, thereby generating undulatory currents, which are sent over the line, and which upon their arrival at the receiving-station are subdivided and received acoustically in the telephonic receivers.

Fig. 16 illustrates the arrangement of a transmitter for the observation of submarine sounds or vibrations, the transmitting-instrument being suspended beneath a float. The preferred construction of this instrument is shown in Fig. 18. It is constructed in such manner as to prevent a sudden increase of pressure from forcing the diaphragm against the poles of the electro-magnet. To this end I inclose the apparatus in a box, one of the sides of which is a diaphragm, H, to which is fixed a rod, *u*, which projects inwardly toward a similar rod, *u'*, which is fixed to the diaphragm F, which latter diaphragm is the one which is disposed closely adjacent to the poles of the magnet G. A tube, *v*, having its ends split, embraces the rods *u u'* and connects them together in such manner that the vibrations of the diaphragm H are transmitted through it to the diaphragm F; but if an excessive pressure of water comes against the exterior diaphragm, thereby pressing the latter inward, the tube *v* yields without injuring the apparatus, and the vibrations continue to be transmitted and consequently to induce undulatory currents upon the line.

My phono-signal may be combined with duplex and other telegraphic systems.

The velocity of subdivision of the current, which I have hereinabove stated to be constant, is not necessarily or essentially absolutely constant, but is preferably so, in order that the musical note heard in the receiving-instrument shall not be subject to variations of pitch, which would confuse or annoy the listener. The speed of the commutator may vary from time to time without departing from my invention.

I claim as my invention my improved system of and apparatus for the transmission and reception of telegraphic and other electrical signals, presenting the following-defined novel features, substantially as hereinabove specified, namely:

1. The reception of electric signals by subdividing the electric current into pulsations succeeding one another at a constant velocity which corresponds to the vibrations of an audible note, and passing the subdivided current through a telephonic receiver, thereby producing in the latter a sound of uniform pitch, the intensity of which varies according to the undulations of the subdivided current, whereby the electric signals are acoustically translated.

2. The transmission of electric signals by sending a succession of electric impulses over the line, subdividing the resulting undulatory current at the receiving-station into pulsations succeeding one another at a constant velocity which corresponds to the vibrations of an audible note, and passing the subdivided current through a telephonic receiver, whereby the electric signals are acoustically translated.

3. The combination, with an electric signaling-circuit, of a commutator at the receiving-station adapted to subdivide the currents arriving over said circuit into pulsations succeeding one another at a velocity corresponding to the vibrations of an audible note, and a telephonic receiver through which the subdivided current is passed.

4. The combination, with an electric signaling-circuit divided into two branches, of a commutator adapted to direct the current into said branches alternately and to shift it from one to the other with a frequency corresponding to the rapidity of vibration of an audible note, whereby the current is subdivided into rapidly successive pulsations in said branches, and with a telephonic receiver intercalated in one of said branches.

5. The combination, with an electric signaling-circuit divided into two branches, of a commutator adapted to direct the current into said branches alternately and to shift it from one to the other with a frequency corresponding to the rapidity of vibration of an audible note, whereby the current is subdivided into rapidly successive pulsations in said branches, and with telephonic receivers intercalated in said branches.

6. The combination, with an electric signaling-circuit and a telephonic receiver, of a commutator at the receiving-station adapted to subdivide the current arriving over said circuit into pulsations succeeding one another at a constant velocity corresponding to the vibrations of an audible note, and circuit-connections between said commutator and the telephonic receiver, substantially as described,

so that the successive pulsations are passed through said receiver in alternately opposite directions.

7. The combination, with an electric signaling-circuit, of a commutator at the receiving-station adapted to subdivide the current arriving over said circuit into pulsations succeeding one another at a velocity corresponding to the vibrations of an audible note, a telephonic receiver through which the subdivided current is passed, and a source of power independent of said circuit for actuating said commutator, whereby the said commutator may be caused to act with a constant velocity uninfluenced by variations in the signaling-circuit.

8. The combination, with an electric signaling-circuit, of a vibratory commutator at the receiving-station adapted to subdivide the currents arriving over said circuit, a telephonic receiver through which the subdivided current is passed, and a rheotomic magnet for vibrating said commutator, adjusted to vibrate it at a constant velocity corresponding to the vibrations of an audible note.

9. The combination, with an electric signaling-circuit and a telephonic receiver, of a commutator at the receiving-station adapted to subdivide the currents arriving over said circuit, a rheotomic magnet for vibrating said commutator, adapted to vibrate it with a velocity corresponding to the vibrations of an audible note, and a source of electric current independent of said circuit for actuating said rheotome, whereby the rapidity of vibration thereof may be rendered constant.

In witness whereof I have hereunto signed my name in the presence of two subscribing witnesses.

CLEMENT ADER.

Witnesses:
ROBT. M. HOOPER,
AMAND RITTER.