(No Model.)

G. T. WOODS.

TELEPHONE SYSTEM AND APPARATUS.

No. 371,241. Patented Oct. 11, 1887.

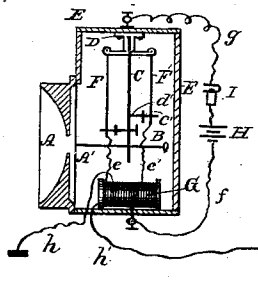

Fig. 1.

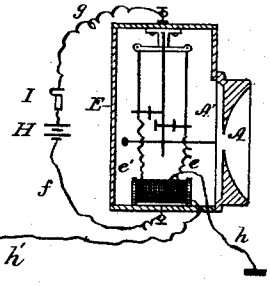

Fig. 2.

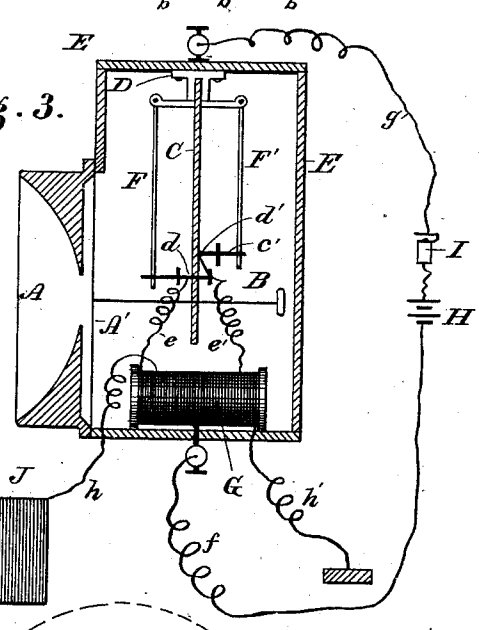

Fig. 3.

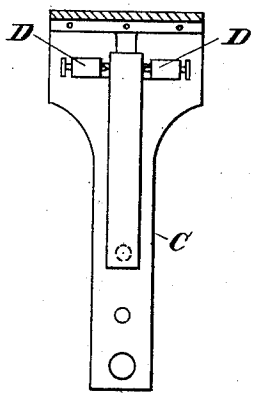

Fig. 4.

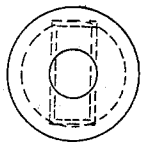

Fig. 6.

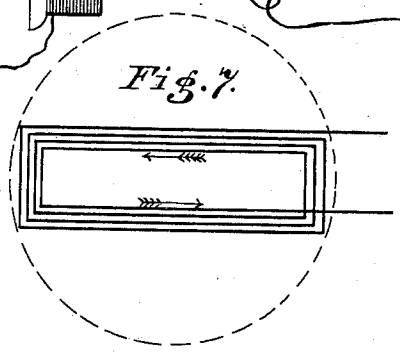

Fig. 7.

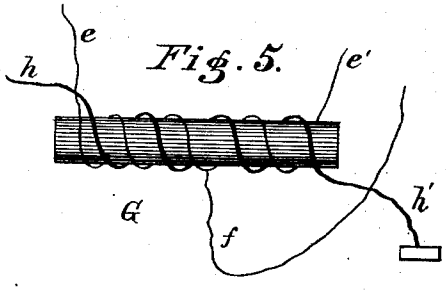

Fig. 5.

Witnesses

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UNITED STATES PATENT OFFICE.

GRANVILLE T. WOODS, OF CINCINNATI, OHIO, ASSIGNOR TO THE WOODS ELECTRIC COMPANY.

TELEPHONE SYSTEM AND APPARATUS.

SPECIFICATION forming part of Letters Patent No. 371,241, dated October 11, 1887.

Application filed June 1, 1885. Serial No. 167,140. (No model.)

To all whom it may concern:

Be it known that I, GRANVILLE T. WOODS, a citizen of the United States, residing at Cincinnati, Ohio, have invented new and useful Improvements in Telephone Systems and Apparatus, of which the following is a specification.

My invention relates to a method of and apparatus for the transmission of articulate speech and other sounds through the medium of electricity, its object being to obtain an increased force of transmission of the impulses controlling the action of the diaphragm at the receiving end; also, to obviate the disturbing effects now attributed to induction from neighboring lines.

The nature of my invention will be more clearly understood from the subjoined description, in connection with the accompanying drawings, forming part of this specification, in which the parts referred to are indicated by letters of reference.

In the drawings, Figure 1 is a diagram of the entire system arranged for use; Fig. 2, a graphical representation of the electrical current as modified and utilized in the transmission of speech or sound by my invention; Fig. 3, an enlarged vertical cross-section of the transmitting-instrument; Fig. 4, a detached side elevation of the "vibrator;" Fig. 5, a diagram explanatory of the construction of the induction-coil and connections; Figs. 6 and 7, detail views of the receiving instrument.

My invention differs from the ordinary methods of electrical transmission of speech in two essential particulars: First, I employ in the primary or local circuit under control of the sending-diaphragm a non-continuous or intermittent current, which by the action of the sending-diaphragm is alternately shunted by media of varying conductivity in opposite directions through the primary of an induction-coil, producing, second, alternating currents of opposite polarity in the line-circuit.

By the first-mentioned feature I obtain a current of far greater inducing strength in the primary of the coil, and by the latter a reversal of the polarity of the diaphragm in the receiving-instrument, whereby the diaphragm is both attracted and repelled, thereby increasing the range and force of its vibrations and producing more vigorous air-vibrations and louder sounds. I also obtain a more forcible transmitting-current and the counter action of static effects, whereby I am able to transmit through longer distances.

An explanation of the principles involved will be given in connection with the following description of the form of apparatus illustrated in the drawings. A designates the mouth-piece, and A′ the ordinary diaphragm, of a transmitting apparatus. In rear of the diaphragm is suspended a vibrator or pivoted arm, C, connected below by a light rod, B, centrally with the diaphragm, so as to vibrate in unison with the diaphragm under the impulses of sound delivered upon the latter. The bracket D, from which the vibrator C is suspended, is extended laterally, and from its extended arms are suspended two pendulous bars or conductors, F F′, at opposite sides of the vibrator C, and at the lower end of each of the bars F F′ is a carbon electrode, *c c′*, one upon each, held by an adjusting-screw threaded through its bar. The carbon electrodes rest at all times against contact-buttons *d d′*, attached to the vibrator C, one at each side, and from these contacts depend conducting-wires *e e′*, the two connecting with opposite ends of the primary of an induction-coil, G. Midway of the said primary is attached a conducting-wire, *f*, extended to a battery, H, thence to an automatic circuit-breaker or "rheotome," I, and thence by wire *g* to the bracket D. The vibrator C being insulated, the local circuit thus formed is as follows: Battery H to rheotome I, thence by wire *g* to bracket D, thence by a loop, including the duplicate pendulous bars F F′, carbons *c c′*, contacts *d d′*, wires *e e′*, and the ends of the primary of induction-coil G, to the center connecting-wire, *f*, and back to battery. The line-wire *h h′*, including the secondary of the coil G, is shown extending to a receiver, J, at one end and to ground at the other.

The apparatus is to be carefully adjusted, so that when normally at rest the local battery-current will divide at the loop and pass equally at the sides of the vibrator and into the induction primary from opposite ends to the center,

thereby establishing an equilibrium of inducing effects of opposite polarities.

The action of the rheotome will be explained later.

If, now, the diaphragm A' be set in vibration by sound-waves, the vibrator C will at once partake of its movements, and the equilibrium of resistances between the carbon electrodes *c c'* being destroyed the divided current will alternately predominate at one side or the other of the vibrator through the pendulous bars F F' and wires *e e'*, and consequently alternate in force and direction through the respective ends of the induction primary G, with the effect of setting up induced currents of reversed polarity in the induction secondary and line *h h'*. In order to trace and analyze this action it should be remembered that sound effects in transmission are wholly converted into electrical impulses, and that all overtones and other delicate constituents of ordinary speech are also converted into and transmitted as electrical vibrations or pulsations of an intensity (range of movement) and successive rapidity corresponding with the sound-waves actuating the diaphragm. So far as concerns the mere transmission over the line, it is immaterial what is the polarity of the induced current. The change from a current of one polarity to a current of the other in this case does not impede or affect the character of the impulses, for the reason that these are produced by the responsive variations of resistance in the carbon electrodes, and these variations are always referable to a common neutral point of perfect equilibrium, whence the variations depart and to which they again return. This will be perhaps clearer by taking into consideration the action of the receiving-instrument, which we may suppose to embody a diaphragm controlled by the action of a magnet. Ordinarily, the diaphragm is controlled solely by a constant attraction of varying force opposed by the elasticity of the diaphragm itself; but even here each sudden impulse or increase of attraction is followed by an elastic reaction of the diaphragm, whence the necessary range of movement is obtained. Where, however, as in the present case, the impulses due to currents of one polarity are succeeded by corresponding impulses of the opposite polarity, the receiving-diaphragm is controlled, not solely by attraction, but by an alternating repulsion and attraction, by which the range of movement of the receiving-diaphragm is increased and louder sound effects produced. Thus the action of my invention, as compared with the common method of transmission by a continuous current of varying intensity, is analogous to that of a double-acting steam-engine as compared with a single-acting engine.

It remains now to consider the function of the rheotome in the connection shown. This will be best understood by considering that induced currents are produced by alternations of impulse in the primary, and that an induced current of stronger electro-motive force is produced by a make and-break current than by a continuous current of varying impulses. My object, therefore, in introducing the rheotome is to obtain thereby a stronger induced current, having a greater carrying-power in transmission, (so as to be independent of static effects and outside disturbing causes and carry longer distances,) and to produce a more vigorous effect at the receiving end.

The action of the rheotome is wholly independent of the transmitting functions of the apparatus, excepting as it adds to the effect in degree. Its vibrations being far more rapid than the movements of the diaphragm, we may represent the current, modified by its action, graphically, as in Fig. 2 of the drawings, in which the vertical lines *a* represent the electrical impulses, the spaces *b* between being the duration of the breaks, and the relative height of the lines *a*, erected upon a common base, indicating the relative intensity of each separate impulse as a constituent of the larger impulse due to the action of the diaphragm.

The action of the rheotome is somewhat modified by that of the apparatus through which the local current passes. The slight inertia, which has of necessity to be overcome, in the pendulous bars F F' and the carbon electrodes tends to lessen the intervals between successive impulses, and in this respect the action is favorable to the delivery of the transmitted impulses by approximating a continuous current. It may now be explained, also, that the joint action of the two carbon resistance-contacts and the specified arrangement of the induction-coil prevents any interference by the rheotome action with the induced-line currents in the transmission of those impulses corresponding with sound waves. For example, if but a single carbon contact and the ordinary induction-coil were employed, the make-and-break of the rheotome would produce a continuous buzzing noise in the receiving-instrument when the transmitting-diaphragm was at rest. In my apparatus, however, whenever the transmitting-diaphragm is at rest a neutral condition is established in the line by the equilibrium of opposing currents in the primary. Hence, when the diaphragm is at rest no sound is heard. When the diaphragm is in action, however, the successive impulses due to the rheotome are absorbed by the larger impulses due to sound-vibrations, into which they enter as constituents, and assist rather than impede those overtones due to excessive rapidity of vibratory impulses. This result is aided, also, by the partial elimination or shortening of the breaks produced by inertia, as before explained; and it is also probable that this inertia being, like the resistance of the carbons, an unstable element is to some extent controlled by the overtone-vibrations, which approximate those of the rheotome in rapidity, so as to bring about

a varying sympathetic unison, by which the transmitted effects are magnified.

In the production of the induced or carrying currents it will be seen that there are thus combined two separate conditions or causes, both tending to produce said current, to wit, the intermittent action of the rheotome and the variations of tension produced by the diaphragm.

In the transmission of speech by an unbroken "undulatory" current, which is necessarily of low tension, the static conditions, especially on long lines, operate to impede the transmission, and also render the line subject to disturbances by induced currents from other lines. By the use of my invention, however, involving alternately-reversed currents, the static effects are practically neutralized and the disturbances referred to are obviated.

I claim as my invention and desire to secure by Letters Patent of the United States—

1. In a system of telephonic transmission, the combination of a local-battery circuit having a loop, a variable resistance-shunt interposed between the bifurcations of the loop and controlled by the receiving-diaphragm, an induction-coil having its primary interposed between the ends of the loop and centrally connected back to battery, and a rheotome or automatic circuit-breaker controlling the local circuit, substantially as set forth.

2. In a system of telephonic transmission, the local circuit embodying, in combination, a battery, circuit-breaker or rheotome, a bifurcated conductor or loop, adjustable resistance-contacts controlled by the sound-diaphragm and interposed in the bifurcations of the looped conductor to shunt the current alternately from one to the other, and an induction-coil whose primary connects the ends of the looped conductor and is centrally connected back to battery, substantially as set forth.

3. In a system of telephonic transmission, the combination of a battery, circuit-breaker, an alternating carbon switch controlled and operated by the vocal diaphragm, and branch conductors with a double primary induction-coil, said branches uniting at the center of the coil in a single return-conductor, substantially as set forth.

4. In combination with the diaphragm A′, the connecting-rod B, vibrating lever C, pendent conductors F F′ and carbon contacts *d d′*, the rheotome I, and induction-coil G, arranged for operation, as set forth.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

GRANVILLE T. WOODS.

Witnesses:
L. M. HOSEA,
ABRAM MAY.