No. 836,612. PATENTED NOV. 20, 1906.

H. E. SHREEVE.

REGULATING DEVICE FOR TELEPHONE RELAYS AND TRANSMITTERS.

APPLICATION FILED OCT. 26, 1905.

2 SHEETS—SHEET 1.

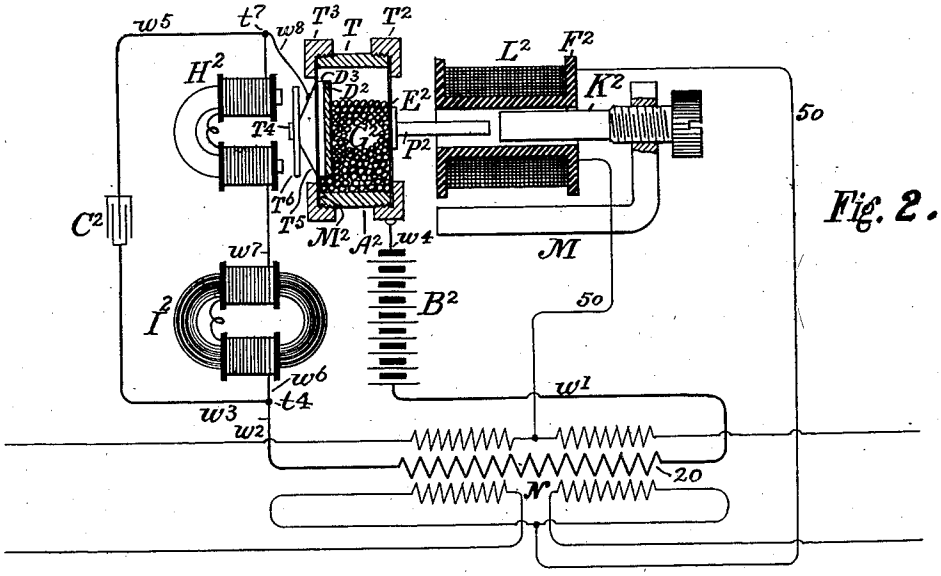

Fig. 2.

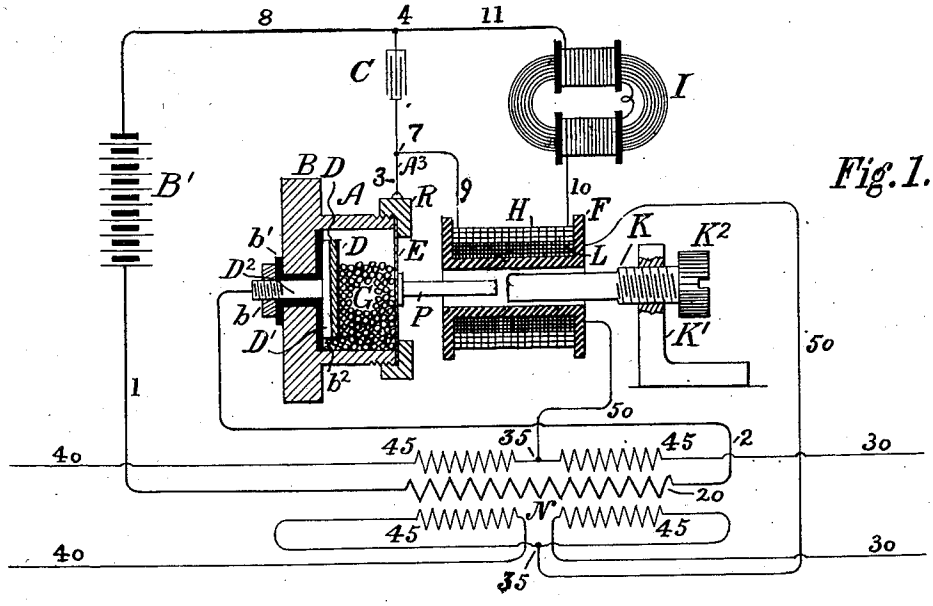

Fig. 1.

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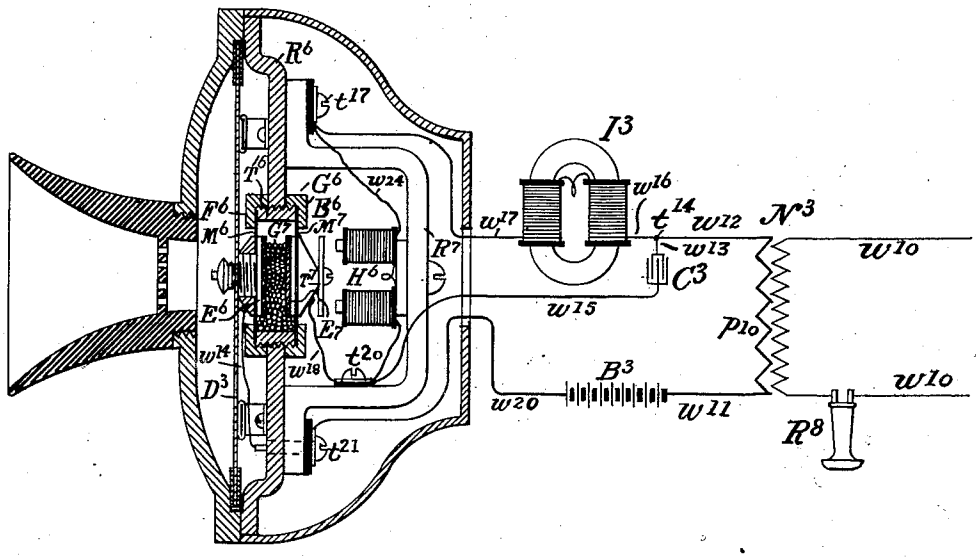
2 SHEETS—SHEET 2.

Fig. 3.



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REGULATING DEVICE FOR TELEPHONE RELAYS AND TRANSMITTERS.

No. 836,612. Specification of Letters Patent. Patented Nov. 20, 1906.

Application filed October 26, 1905. Serial No. 284,450.

To all whom it may concern:

Be it known that I, HERBERT E. SHREEVE, residing at Newton, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Regulating Devices for Telephone Relays and Transmitters, of which the following is a specification.

This invention relates to improvements in telephonic instruments or apparatus—such as current reinforcers, relays, and transmitters—which embody as an element thereof a granular carbon "button" or microphone; but the invention is especially intended as an improvement upon the telephone-current reinforcers or relays of my Patents Nos. 791,655 and 791,656, dated June 6, 1905.

The present invention is designed as a remedy for the packing of the carbon granules in the carbon chamber or button employed in such reinforcers or relays and telephones; and it consists in the combination, with one of the walls of the said carbon-chamber, which is preferably one of the electrodes, either the back electrode or the ordinary front electrode, of an impedance-coil, a condenser, and an electromagnet, the said condenser being in the local circuit of said carbon-chamber, while the said impedance-coil and said electromagnet are in a parallel branch or shunt of the same local circuit around said condenser, and said electromagnet being arranged to impart movement to said movable wall of said carbon-chamber.

The invention also consists, particularly in its application to current reinforcers or relays, in utilizing the electromagnet which sets up the strong initial magnetic field, the latter to be varied by the feeble rapidly-varying voice-currents which are to be relayed, to perform in conjunction with other parts the additional function of overcoming packing of the granular carbon in its chamber. This is effected by including a winding of said magnet in a local circuit through the granular carbon. This local circuit may, if desired, be the local reinforcing and transmitting circuit through the granular carbon, in which case the path of current from one pole of the generator to the microphone is preferably divided into two parallel branches, one including a condenser and the other an impedance-coil and said magnet-winding.

In relays such as described in my patents above enumerated and to a lesser extent in the granular carbon transmitter used independently of relays there is a tendency of the granules in the carbon-chamber to pack, such packing impairing the resistance-varying properties of the mass in responding to relative vibrations of the electrodes, and consequently diminishing the transmitting efficiency of the apparatus. Such packing of the carbon granules—a defect inherent in instruments of this type—is, it is believed, due in part to the natural tendency of the carbon granules to settle toward the bottom of the chamber, particularly under the influence of the slight relative vibrations of the electrodes in the normal operation of the instrument, in part to the constant and slight vibrations going on everywhere, and particularly in buildings where such apparatus are likely to be located, in part to the expansion effects of heat generated in the button, including the granular carbon thereof, by the passage of current therethrough in the normal operation of the apparatus, and possibly to other causes which need not be mentioned.

This invention consists, further, in certain details of construction.

The applicability of the invention to telephone-current reinforcers or relays will be sufficiently illustrated by diagrams which may, if desired, be read in connection with my patents above enumerated.

Figure 1 is a diagram representing the invention as applied to a relay in which the combination of the condenser, impedance-coil, and electromagnet is with the ordinary movable wall or front electrode of the carbon-chamber. Fig. 2 is a diagram representing a similar combination as acting upon the rear or opposite wall of the carbon-chamber. Fig. 3 represents the invention as employed with a granular-carbon telephone.

The invention as illustrated in Fig. 1 will formed by a heavy solid back B, on which is first be described. A is the carbon-chamber, screwed a ring R, so as to hold between them a vibrating front electrode E, to which is rigidly secured a pole-piece P, partaking of its vibrations, or rather whose end-to-end vibrations the electrode follows. D is the back electrode secured to a metallic piece D′ of equal diameter. A projection D^2 from D′

passes through a hole in back B, a nut *b* holding the metallic piece D′ and the back electrode D in position, suitable insulation of hard rubber *b′* and *b²* being provided, as shown. G is the granulated carbon within the carbon-chamber. F is a spool for the winding L, forming the receiving part of the relay, wires 50 50 from the main line connecting therewith, as will be briefly described hereinafter. K is the stationary pole-piece of soft iron adjustable in a frame-piece K′ by a thumb-screw K². H is an independent winding upon the same spool F which serves for the winding L. I is an impedance-coil. C is a condenser. The independent winding H and impedance-coil I are in one branch of the local circuit, forming a closed path for steady currents, while the condenser C is in another parallel branch open to steady currents, but closed for rapidly-varying currents. That portion of said local circuit outside of these two branches includes the relay-battery B′, the primary 20 of an induction-coil, (whose secondaries are connected with the line to be relayed,) the front and back electrodes E and D, the granulated carbon G of the carbon-chamber, and the ring R. This local circuit may be traced as follows: First, the path for rapidly-varying currents from one pole of the battery B′ by wire 1 to one end of the primary 20 of the induction-coil N, from the other end of the primary 20 by wire 2 to the projection D², back electrode D, granular carbon G, front electrode E, ring R, wire 3, terminal or division post 7, condenser C, wire 8, back to the other pole of battery B′. The path for steady currents through the impedance-coil and winding H is the same as just described—from one pole of the battery B′ to terminal or division post 7, thence by wire 9 to one end of winding H, from the other end of winding H by wire 10 to impedance-coil I, by wire 11 to terminal or division post 4, and by wire 8 back to the other pole of battery B′. An important office of the winding H is the same as that of the similar second winding upon the similar spool in my said Patent No. 791,655—viz., to establish a strong initial magnetic field to be varied by feeble pulsations or alternations coming over the line-wires, as hereinafter further explained. Another office of the winding H relates to the present invention. When from any cause the granules in the carbon-chamber become packed, and hence their resistance to passage of current diminished, the direct current in the local circuit through the impedance-coil and winding shunting the condenser is thereby abnormally increased, and this increase causing winding H to act upon the variable pole P to impart an extraordinary movement to the electrode E draws said electrode away from the carbon in the chamber, loosening the mass of particles and the contact thereof with one or both electrodes. This results in a sudden material increase of the resistance of the button and like diminution in the current flowing through the winding H. The pulling power of the relay drops, releasing the electrode E, which having been placed under tension forcibly and vigorously moves inward to its normal position and contracts the chamber, (for the instant to less than its normal size,) the impact of the inwardly-moving wall against the carbon mass breaking it down and spreading its component particles loosely throughout the chamber. This extraordinary movement of the electrode E first in one direction and then in the other, which, as explained, occurs only when the carbon granules have become detrimentally packed in their chamber, being much stronger than the ordinary movements or sound-vibrations effects a material displacement, disintegration, loosening, and consequent unpacking of the granules, thereby restoring them to their normal unpacked or loose condition. Any subsequent repacking reproduces the conditions which will again automatically unpack the granules in the manner explained. This is believed to be the correct explanation of the manner in which the expansion and contraction of the chamber effects the loosening of the packed carbon mass, although it has been found impossible to actually observe the changes which take place therein in operation, owing to the inclosing of said mass, the almost imperceptible movements which effect the changes, and the swiftly successive and recurrent character of the changes. The feeble rapidly-varying voice-currents coming over the line 30 30 circulate in the receiving or magnetization-varying coil L, thereby varying the initial magnetization and the attraction of the magnet, and hence vibrating the movable pole-piece P corresponding to such attraction variations and to the electrical variations or voice-currents of the circuit-traversing coil L. This vibration of the pole-piece (which may be referred to as the ordinary movement thereof to distinguish from the extraordinary movement heretofore mentioned as overcoming packing of the carbon granules) actuates electrode E, which in turn acts upon the carbon particles to vary the resistance therethrough of the local circuit of battery B′, thereby producing in said local circuit strong pulsating currents corresponding to the feeble voice-currents coming in over line 30 30. Through the action of primary winding 20 and secondary windings 45 the local circuit reproduces the strong pulsating currents in the outgoing line 40 40. The strong pulsating voice-currents produced in the local circuit, as above explained, are forced by the impedance-coil to take the path through the condenser, thereby preventing a cycle of reactions, which would cause the phenomenon of "singing" if the

said rapidly-varying currents in the local circuit were permitted to flow freely through the magnetizing-coil H. In successful experiments with a relay such as is described in my said previous patents I have found it sufficient employing a carbon button of the ordinary size to give the condenser C a value of four microfarads and to use an impedance-coil consisting of five thousand three hundred and twenty turns of No. 23 copper wire wound around an iron core. In the electromechanisms of my said former patents, upon which the present invention is an improvement, an important feature is the control of the pole-piece rigidly secured to the front electrode of the transmitting portion of the relay by a coil in the receiving portion of the relay in the manner hereinbefore explained. The connections of this coil (marked L in the figure under consideration) with the line which is to be relayed may briefly be stated as follows: 30 30 are the two wires of the incoming line, and 40 40 are the two wires of the outgoing line, or 40 40 may be regarded as the incoming and 30 30 as the outgoing line. They connect, as shown, with the ends of two secondary windings 45 45 of the induction-coil N, the primary of which has been mentioned, which have at their middle points the terminals 35 35 of a bridge composed of wires 50 50, connected with the two ends of the winding L, designed to set up end-to-end vibrations of the variable pole P. The windings of the secondaries 45 45 upon each side of the terminals 35 35 are in the same direction, so that currents in the secondaries shall be in the same direction, reinforcing one another in the main circuit.

Instead of employing, as in Fig. 1, an electromagnet energized by a winding in the local circuit through the granular carbon to establish the strong initial magnetic field and utilizing the same magnet and its said winding to impart to one electrode of the microphone the extraordinary movement which unpacks the carbon in the embodiment of the invention illustrated in Fig. 2 I have shown a permanent magnet for establishing the initial magnetic field and an independent electromagnet in the local circuit through the carbon for the impartation of such desired extraordinary movement of the electrode. In this figure of the drawings is illustrated the combination of impedance-coil, condenser, and electromagnet with the back electrode of the carbon-chamber A^2, which said chamber is formed in this instance by screwing a thimble T into a front piece T^2, so as to hold between them the front electrode E^2, and then screwing upon the thimble T a back piece T^3, so as to hold between them a mica plate M^2. D^2 is the back electrode, preferably of carbon, secured to a metallic piece D^3 of equal diameter, a projecton T^4 from which passes through said mica plate M^2, through a back T^5, and through an iron plate T^6, which is screwed upon said projection and serves as an armature for an electromagnet H^2, whose office will appear. G^2 is the granulated carbon. P^2 is the vibrating pole-piece rigidly connected with front electrode E^2 and entering about half-way a spool F^2, upon which is wound the winding L^2, whose ends are connected by bridge-wires 50 50 with induction-coil N. M is a permanent magnet, a fixed but adjustable pole-piece K^2 being screwed therethrough, as shown. This magnet and fixed pole-piece establish the strong magnetic field to be varied by feeble alternations coming over the main line. The induction-coil N is the same as the induction-coil used in Fig. 1, and its connections with the delicate receiving apparatus of the relay shown at Fig. 2 are the same as in Fig. 1. I^2 is an impedance-coil. C^2 is a condenser, and B^2 is the relay-battery. The local circuit may be traced as follows: from one pole of battery B^2 by wire w' to one end of the primary 20 of induction-coil N, from the other end of primary 20 by wire w^2 to terminal t^4, thence by wire w^3 and condenser C^2, wire w^5 to terminal t^7, by wire w^8 to back electrode D^2, granulated carbon G^2, front electrode E^2, wire w^4, to the other pole of battery B^2, or from terminal t^4 by wire w^6 to impedance-coil I^2, to wire w^7, to electromagnet H^2, terminal t^7, &c.

It will be readily seen that when from any cause the granules in the carbon-chamber shown at Fig. 2 pack the direct current in the local circuit through the winding of the electromagnet H^2 will draw back the back electrode D^2 from the carbon-chamber, effecting an unpacking of the carbon in substantially the manner explained with reference to Fig. 1, with consequent increase of resistance and decrease of current in the local circuit. The resiliency of the mica plate M^2 affords sufficient movement or play to the back electrode D^2 for the purposes of the invention. It will be observed in Fig. 2 that no bridge or similar support is used to hold the back electrode of the button. The bridge is not essential, provided the electrode has a sufficient amount of inertia. It is unnecessary to further describe the operation of the apparatus shown in Fig. 2.

The application of the invention to an ordinary carbon-button transmitter (fully illustrated in Fig. 3) requires but a brief description, since the construction very closely resembles that of the telephone-current relay shown in Fig. 2. The carbon button G^6 is thus put together: A thimble T^{16} is screwed into a bridge-piece R^6 and on said thimble outside of the bridge-piece are screwed front piece F^6 and a back piece B^6, holding between said thimble and said pieces mica plates M^6 and M^7, forming movable walls for the carbon-chamber, to which are secured the front and back electrodes E^6 and E^7, the former of

which is rigidly secured to the diaphragm D^3 of the transmitter. G^7 is the granular carbon. H^6 is an electromagnet bolted, as shown, to a second bridge-piece R^7, which is secured to the first bridge-piece R^6 by screws. (Not shown.) T^7 is an iron plate forming an armature for electromagnet H^6. Outside of said transmitter B^3 is the local battery, C^3 is the condenser, and I^3 is the impedance-coil. N^3 is an induction-coil for connecting the transmitter and the additional parts involving the present invention with the line w^{10} w^{10}, over which the voice-currents are to be transmitted, R^8 being an ordinary telephone-receiver. t^{17}, t^{20}, and t^{21} are insulated terminals or division-posts. The circuits may be traced as follows: from one pole of the battery B^3 by wire w^{11} to one end of the primary p^{10} of the induction-coil N^3, from the other end of primary p^{10} by wire w^{12} to terminal t^{14}, thence (for rapidly-varying currents) by wire w^{13} and condenser C^3, wire w^{15} to division-post t^{20}, by wire w^{18} to back electrode E^7, granulated carbon G^7, front electrode E^6, wire w^{14} to insulated post t^{21}, wire w^{20} to other pole of battery B^3, or for steady currents from terminal t^{14} by wire w^{16} to impedance-coil I^3, wire w^{17}, insulated post t^{17}, wire w^{24}, to electromagnet H^6 to division-post t^{20}, &c.

What I claim is—

1. In a telephone or telephone-current relay employing finely-divided variable-resistance material as an essential part of the transmitting portion, the combination with the said variable-resistance material, a battery or source of electromotive force in circuit therewith, and a movable electrode in the chamber containing said resistance material, of an electromagnet adapted to control said movable electrode, an impedance-coil, and a condenser, the said electromagnet and impedance-coil, and the said condenser, shunting one another, or being respectively in parallel branches of the circuit of said source of electromotive force and variable-resistance material.

2. In a telephone-current relay or analogous instrument employing a chamber containing granulated carbon in a local circuit as the transmitting portion of said relay, one wall of said chamber being made movable, the combination with said movable wall and the battery or source of electromotive force in said local circuit, of an electromagnet adapted to control said movable wall of said chamber, an impedance-coil and a condenser, the said electromagnet and said impedance-coil shunting said condenser in said local circuit.

3. In a telephone-current relay or analogous instrument employing an electromagnet as an essential part of the receiving portion of the relay and a granulated carbon button as the transmitting portion, the winding of said electromagnet being adapted to operate the front electrode of said button by currents in said winding coming over the main line, the combination with said button and said electromagnet, of a local circuit including a battery, an impedance-coil, a condenser, and a second winding for said electromagnet, the said impedance-coil and said second winding shunting said condenser in said local circuit.

4. In a telephone-current relay or analogous instrument employing an electromagnet and having a granulated carbon button as its transmitting portion, said electromagnet having two windings and being adapted to operate one electrode of said button by currents coming over a main telephone-line to one of said windings, the combination with said button and magnet of a local circuit leading through the granular carbon of said button and including a generator and the other winding of said magnet.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 23d day of October, 1905.

HERBERT E. SHREEVE.

Witnesses:
GEO. WILLIS PIERCE,
JOSEPH A. GATELY.