(No Model.)

A. BERNSTEIN.

APPARATUS FOR COUNTERBALANCING DISTURBANCES IN TELEPHONES.

No. 286,577. Patented Oct. 16, 1883.

Fig. 1.

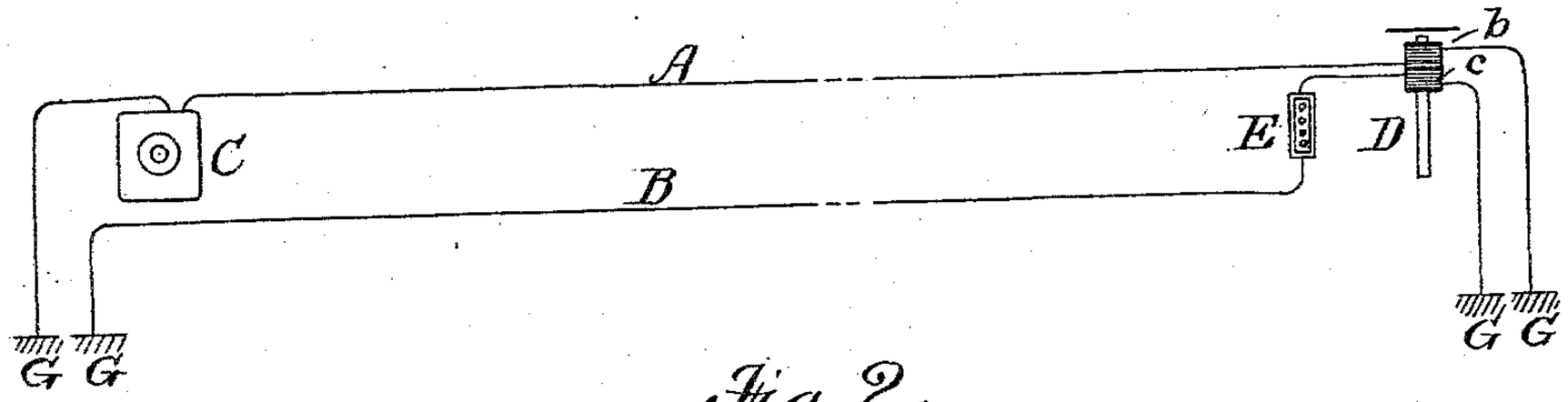


Fig. 2.

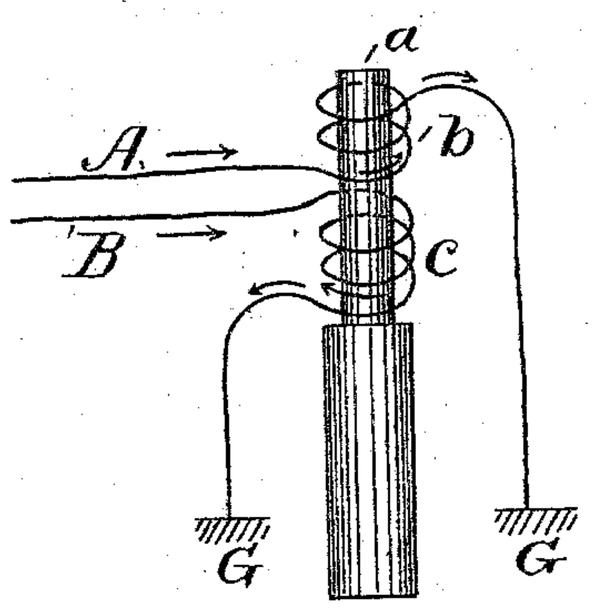


Fig. 4.

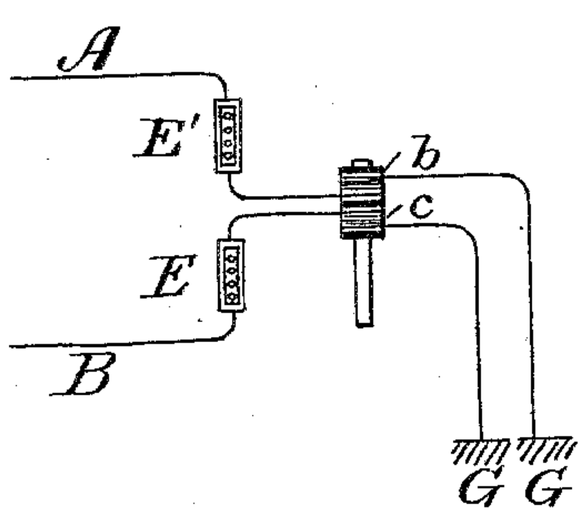
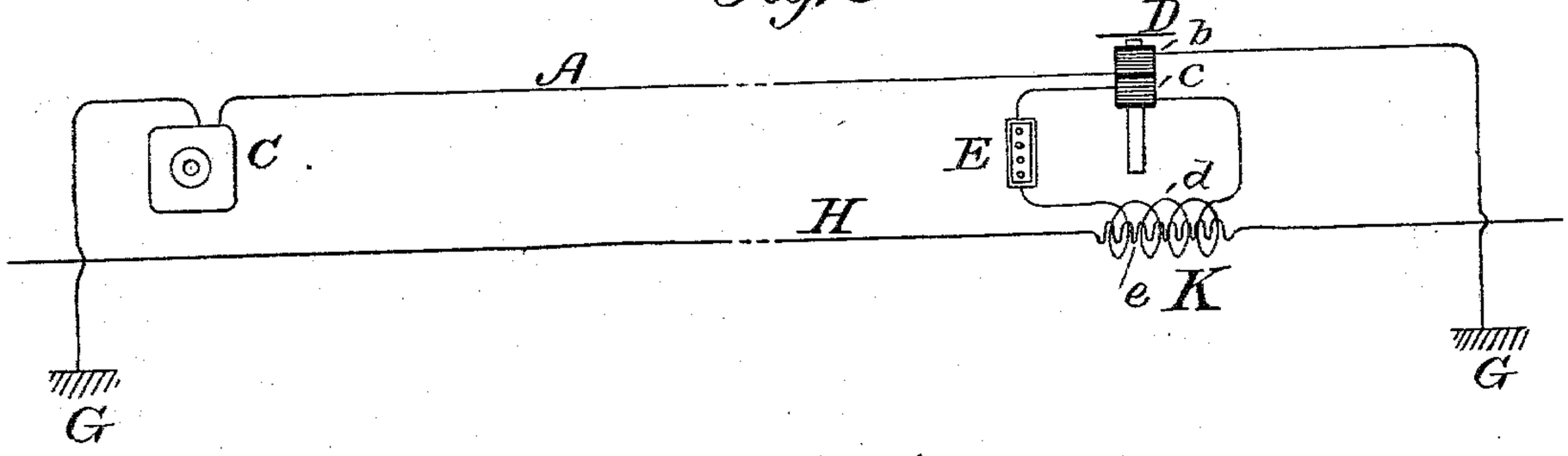


Fig. 3.



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ALEX. BERNSTEIN, OF BOSTON, MASSACHUSETTS.

APPARATUS FOR COUNTERBALANCING DISTURBANCES IN TELEPHONES.

SPECIFICATION forming part of Letters Patent No. 286,577, dated October 16, 1883.

Application filed May 14, 1883. (No model.)

To all whom it may concern:

Be it known that I, ALEX. BERNSTEIN, of Boston, in the county of Suffolk and State of Massachusetts, have invented a certain Improved Method of and Apparatus for Counterbalancing Induction Disturbances in Telephones, of which the following is a specification.

My invention relates to telephone-circuits and to the construction of telephones in an improved manner, whereby the detrimental effects of induction may be greatly decreased, and, in many cases, practically eliminated. The articulating-currents are, especially when circulating in a long line, extremely feeble, and the telephone itself is, and evidently must necessarily be, an instrument correspondingly delicate and sensitive, in order that it may be acted upon by such currents. The telephone is, however, in virtue of its excessive sensibility, liable to be influenced greatly by foreign electrical currents induced in its conducting-wire by the currents traversing other conducting-wires adjacent thereto. Moreover, these induced currents frequently act so strongly upon the telephone-circuit, and, consequently, in the telephone itself, as to drown the articulations, and to render oral communication difficult, and in some cases impossible. Particularly is this the case when the telephone-wire extends for a long distance parallel with or adjacent to other wires, conveying relatively strong currents—such as those used in telegraphy or electric lighting—while the annoyance is also considerable even when the disturbing-wire conveys a telephonic current also.

The object of my invention is to counterbalance, compensate, or neutralize the effects of this induction in an effectual, simple, and economical manner, and thus to render the operation of long lines practicable even when they are extended upon supports already utilized for other conducting-wires. By the achievement of this object telephone-wires may be extended upon a system of poles upon which, for example, telegraph-wires are supported, while heretofore special supports have been essential, and the telephonic communication may then be readily established between any two or more points which would, on the score of economy, remain unconnected were a special line of supports necessary. Railways may also avail themselves of this invention to utilize the telephone-wire as a medium of communication between their several stations, which would otherwise be impracticable on account of the telegraph-wires which are usually extended along the line of road.

The chief remedy which has hitherto been proposed for inductive disturbances has been the employment of a return-wire parallel to and near the first, instead of an earth-return. This, however, is only sufficient when the wires are near to one another and both wires equidistant from the disturbing-wire; and is, moreover, objectionable from the fact that twice the amount of line-wire and twice the labor in construction become necessary. In order to attain the desired object, I make use of a compensating-circuit, and by a peculiar construction of the receiving-telephones and arrangement of the circuit in connection with the said telephones the induction is neutralized in the telephone, while the articulations are emitted clearly and distinctly. This compensating-circuit, as I shall hereinafter show and describe, may consist of an extra line-wire, which either extends along the whole or a part of the telephone circuit-line, or which is entirely placed in the receiving-station, and in this later case takes the form of an induction-coil.

I shall describe, first, the conditions appertaining to the first case, in which an extra line-wire is employed, the said extra wire being independent of the wire which conveys the telephonic current, which latter I shall hereinafter designate as the "main wire." The extra wire, running parallel to the main wire, is exposed in common therewith to similar inductive action from the interfering wire or wires, and I combine the results of the inductive action in the main wire with those in the extra wire in such a manner as to counterbalance one another in the receiving-telephone.

The action of the ordinary receiving-telephone depends on the variation in the magnetization of the permanent magnet contained in the telephone, and it is most desirable that this variation should be perceptibly effected only by the varying currents developed in the transmitter. The effect of induction on the telephone-wire is to either increase or decrease the normal magnetization in an irregular man-

ner, so as to interfere perceptibly with the successful reproduction of articulate speech, and to render the same indistinct. By the addition of the extra wire the proper amount of magnetization in the receiving-telephone is again restored. To enable this extra wire to act on the receiving-telephone I employ two bobbins or helices on the core of the magnet of the said receiving-telephone, both wound with wire of the same size and length; but one of the two bobbins—say the one included in the main-line circuit—is wound with a right-handed helix, while the other bobbin (that included in the circuit of the extra wire) is wound left handed. If the two wires are equidistant from a third and disturbing-wire, the current induced by the said disturbing-wire will have an equal strength in both main and extra wire, provided both are of the same length and that the resistance of both lines is the same; but the effect of these induced currents on the magnet of the telephone will be null, as the currents pass through the helices in opposite direction, and the magnet will therefore be subject and respond only to the variations of current produced in the transmitter.

In the drawings, Figure 1 is a theoretical diagram representing the arrangement of the main and extra wire, and Fig. 2 an enlarged view of the mode in which the helices encircle the receiving-telephone magnet.

A represents the main line, C the transmitter, D the receiving-telephone, and B the extra wire. The telephone D is provided with two spools or bobbins oppositely wound, *b* being in circuit with the main wire A, and *c* in circuit with the extra wire B. Both main and extra wires are connected with the ground G at both termini. A rheostat or variable resistance, E, is inserted in the circuit of the wire B near the receiving-telephone, for a purpose which will be hereinafter explained.

In Fig. 2, which represents on a larger scale the active end of the receiving-telephone magnet and core, a few convolutions of each wire are shown as encircling the core *a*, these indicating the helices *b* and *c* connected, respectively, with the main and extra line wires. They are shown in diagram for greater clearness.

I shall now proceed to show the inductive action of a third wire running parallel to A and B, and conveying currents varying in strength, duration, or direction. It should be here understood that the wires A and B are supposed to be substantially equal in resistance and length and equally distant from the third wire. Under these conditions the induced currents in A and B are of the same direction and are equal in strength. If, now, the induced currents are of the direction indicated by the arrows in Fig. 2, they will traverse the coils *b* and *c* in the direction also therein indicated, and their effect upon the magnet will be thus neutralized. In the event of the induced currents being of opposite direction, the ultimate result would obviously be the same. In this way the inductive effect of a current in a third wire is counterbalanced or compensated in regard to the effect on the telephone. I have so far assumed that the wires A and B are equidistant from the third and interfering wire; but it is not possible that such a condition can always occur. If the extra wire B is nearer to the disturbing-wire, the current induced in B by the said wire will be stronger than the one simultaneously induced in A; or, if the extra wire B is more distant than A from the disturbing-wire, the current induced in B by the said wire will be weaker than that induced in A. In order to counterbalance these conditions, I introduce, as hereinbefore stated, the adjustable resistance E into the circuit of the extra wire B, and in so doing I am enabled to equalize the induced currents, whereby their action upon the receiving-telephone will also be equalized. The most convenient way to effect this equalization is in all cases to arrange the rheostat E in the circuit, so that its resistance may be varied to suit the varying conditions of the lines. So long, then, as the lines A and B are equidistant from the disturbing-wire and equal in length and specific resistance, it is obvious that the adjustable resistance is not necessary. I have, however, found it very convenient in any event to insert a standard resistance, E, in the circuit of B, which may be decreased if the induced currents in B become weaker than those in A, or which may be increased if the currents in B become stronger than those in A. This arrangement is advantageous in view of the varying conditions which take place in circuits, arising from atmospheric or other causes, over which the terminal offices have no direct control, and by which circuits which are normally similar in all respects are frequently caused to differ materially. The adjustable resistance E may thus be varied and adjusted in such a way as to make the effect of induction from a third wire disappear in the telephone. To facilitate the adjustment, another variable resistance, E′, may, if desired, be introduced into the main-line circuit.

Having now shown that in this arrangement the induction from a third wire has no effect in the receiving-magnet, I shall proceed to show that the induction between the main wire and the extra wire is in like manner neutralized. Each variation of the currents in the main wire will necessarily set up an induced current in the extra wire. If the current in the main wire A increases in strength, then the current in wire B will have a direction opposite to the direction of the current in A, and consequently both currents will tend to increase the magnetism of the telephone-magnet *a*, because the convolutions in the helix *c* of the wire B are oppositely wound to those in the helix *b* of the wire *a*. If the current in the main line decreases, the induced current in the extra wire will have the same direction as the current in the main wire, and if the latter one tends to diminish the magnetism of the receiving-magnet, the induced cur-

rent in the extra wire will, by passing round the core in an opposite direction, by means of its oppositely-wound helix, tend to still further decrease the magnetic strength of the core. These effects will be obtained irrespective of the direction of the current in the main wire, and the extra wire and auxiliary helix in circuit therewith will therefore aid in increasing the efficiency of the telephone. I have so far assumed that the wires A and B are of equal length; but this is not essential, for if the length of the extra wire B is but one-tenth of the main wire A, the electro-motive force of the induced current will be but one-tenth of the amount formerly obtained, and if, now, the resistance of wire B is made but one-tenth of what it was before, the current in the helix thereof, surrounding the core *a* of the receiving-telephone, would have the same strength as before. It is therefore evident that the extra wire B may be of any length, while its effect can be always adjusted in such a way as to annul the effect of induction from a third wire; but I may, as hereinbefore indicated, dispense with the extra wire along the line altogether, placing this extra wire entirely in the receiving-station. Fig. 3 represents my arrangement for so doing. In the figure, H represents the disturbing-wire, which may be a line used for telegraphic or other purposes. In the receiving-station I cause the circuit of the said line H to pass through or include the primary helix *e* of an induction-coil, K, of suitable resistance. As in the preceeding figures, A is the telephone-wire; C, the transmitter; D, the receiver, having the oppositely-wound helices *b* and *c*. The secondary helix *d* of the induction-coil now takes the place and assumes the functions of the extra wire B in the former cases. This secondary coil is in circuit with the coil *c* of the receiving-telephone and with the rheostat or adjustable resistance E, the said resistance being introduced for the hereinbefore-described purposes. The induction-coils may be made adjustable, and by means of such adjustment and of the variable resistance E the effects of induction on the wire A are subdued and overcome, being neutralized by a counter-induction set up by the same disturbing-force exerted through the telephone in an opposite direction to that of the original disturbing-currents, as fully explained above. The secondary wire of the induction-coil K has exactly the same function as the extra wire B, and is practically an electrical equivalent therefor, condensed into a small compass. When the action of every wire singly on the telephone is properly balanced, then the simultaneous action of any number of them will correspondingly be well balanced.

It is evident that instead of one neutralizing-coil, *c*, there may be as many such coils as there are induction-coils K; but this would not improve the general result, and would be a needless complication.

I will observe in conclusion that the essential feature of my invention is that the inductive disturbances are annulled by a compensating action which takes place in the telephone itself, by means of an additional and opposing action of another induction-current, produced from the same source as the original disturbing-current, the effect of which in the said telephone is to exactly counterbalance the disturbance caused by the induction-currents in the line-wire, the final result of this compensation being the reproduction of speech in the telephone in a manner as free from interfering noises as if no induction in the line-wire had taken place.

So far as I am aware all attempts to eradicate or neutralize the hurtful effects of telephonic induction prior to my invention were made upon the line-wire itself, with the intention of accomplishing the said neutralization in the line-circuit. In contradistinction to all such methods I effect the desired result in the receiving-instrument, which may be done much more conveniently.

I may of course, if I so prefer, instead of placing two separate helices upon the magnetic core of the telephone, wind a single bobbin or spool differentially in a manner well understood, and in that case the two wires of the differential spool would be reversely connected with the main and compensating circuits, by which the same object would be effected in a slightly different manner.

It will be understood that although I have herein described my invention with reference to but one receiving-telephone it is equally adapted for application at both or all stations of a telephonic line, the said application being at each station simply a duplication of the arrangements and instrumentalities which I have described.

I make no claim herein to the combination, in a telephone system wherein the telephone-wire is subject to inductive interference from adjacent wires, of a differentially-wound telephone with a telephone-wire connected in circuit with one of the helices of said telephone, and an induction-coil having its secondary coil connected in circuit with the other helix of the said telephone and its primary coil in the circuit of the disturbing-wire; or of such a combination with the addition of a rheostat or variable resistance included in the secondary circuit of the induction-coil, reserving the same for a separate application for Letters Patent; but

What I do claim is—

1. The combination, substantially as hereinbefore described, of a main telephone-circuit, a compensating-circuit, and a receiving-telephone provided with differentially-wound coils or helices, one of the said helices being included in each of the said circuits.

2. A main telephone-circuit, and an induction compensating-circuit therefor, combined with a receiving-telephone having two separate coils or helices surrounding the magnetic core thereof, one of the said coils being in-

cluded in each of the said circuits, and an adjustable resistance in the compensating-circuit, substantially as set forth and for the purposes specified.

3. The hereinbefore-described method of counterbalancing inductive disturbances in a receiving-telephone, which consists in causing currents similar in character and strength to the disturbing-currents to circulate around the magnetic core of the said telephone in a direction opposite to that of the said disturbing-currents.

4. The combination, in a receiving-telephone, of a magnet, a coil or helix of insulated wire surrounding the core thereof, and adapted to be included in the main telephone-circuit, and a second coil of insulated wire wound in a direction opposite to that of the first, and adapted to be included in a compensating-circuit, for the specified purpose.

5. The combination, in a system of electric telephony, of a main telephone-line, an auxiliary or compensating line parallel to the said main line, and a receiving-telephone having its magnetic core encircled by two operating-coils, one for and included in each of the said line-circuits, but wound oppositely or differentially with reference to one another, whereby interfering currents induced in the main-line wire from an adjacent line-wire conveying other electric currents may be counterbalanced in the receiving-telephone by the action of similar currents induced by the said disturbing-wire in the compensating-line circuit, and caused to circulate through the said telephone by means of the second helix in an opposite direction.

6. The combination, in a system of telephonic communication, of a main telephone-line, an extra or compensating line, a receiving-telephone differentially wound, one of the differential coils being in the circuit of the main line and the other in the compensating-line, a rheostat or adjustable resistance in the compensating-line, and a second adjustable resistance in the main line, for the purpose of co-operating in regulating the action of the helices upon the magnetic core thereof, substantially as described.

7. The combination of a main telephone-line, an auxiliary or compensating line parallel thereto, a receiving-telephone having its magnetic core surrounded by two separate coils or helices, one of the said helices being included in the main line and the other in the compensating-line, and a rheostat or adjustable resistance in the compensating-line, whereby any inductive disturbance in the telephone due to induction-currents in the telepone main-line helix is counterbalanced by the circulation of similar induction-currents in an opposite direction in the compensating-helix, and whereby the induction-currents in the auxiliary line may be caused to balance the induction-currents in the main line, irrespective of variation in the distance of the two wires from the cause of disturbance, by varying the resistance of the said auxiliary line, as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 5th day of May, 1883.

ALEX. BERNSTEIN.

Witnesses:

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