(No Model.)

T. SPENCER.

TELEPHONE CIRCUIT.

No. 505,730. Patented Sept. 26, 1893.

Fig. 1.

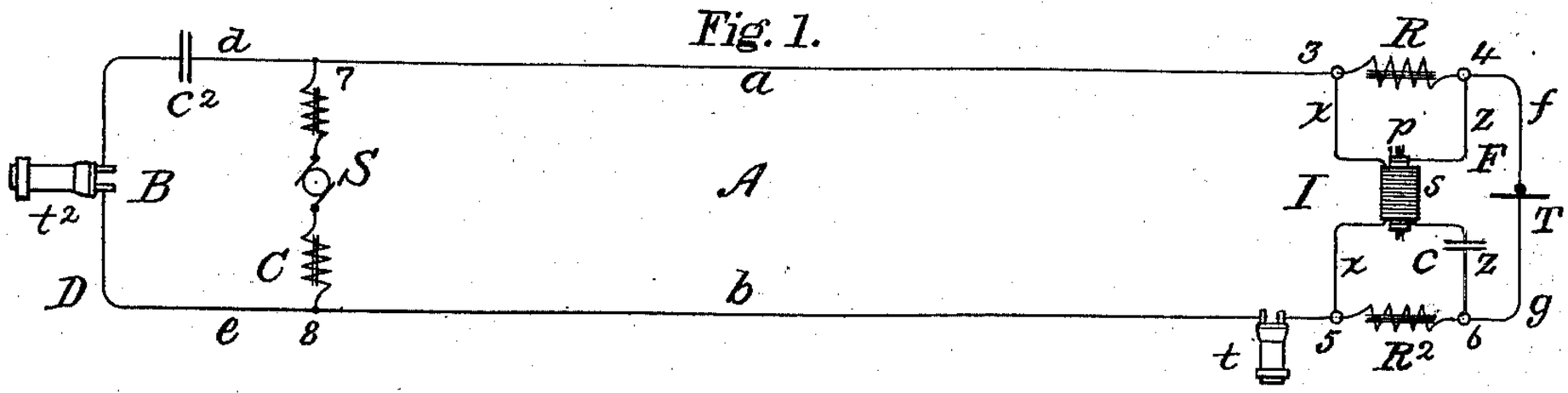


Fig. 2.

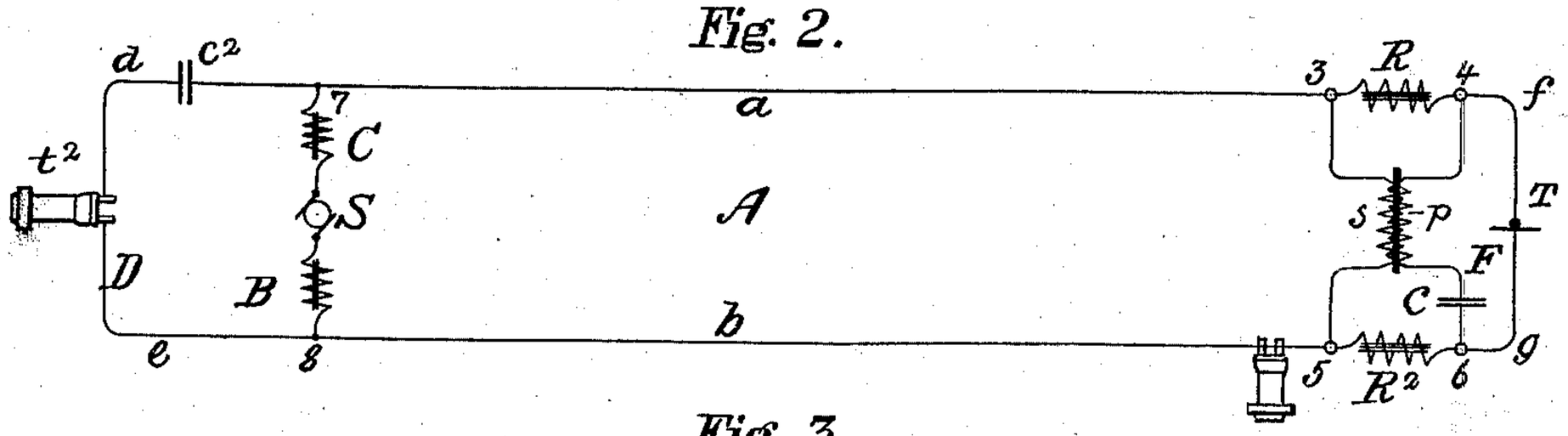


Fig. 3.

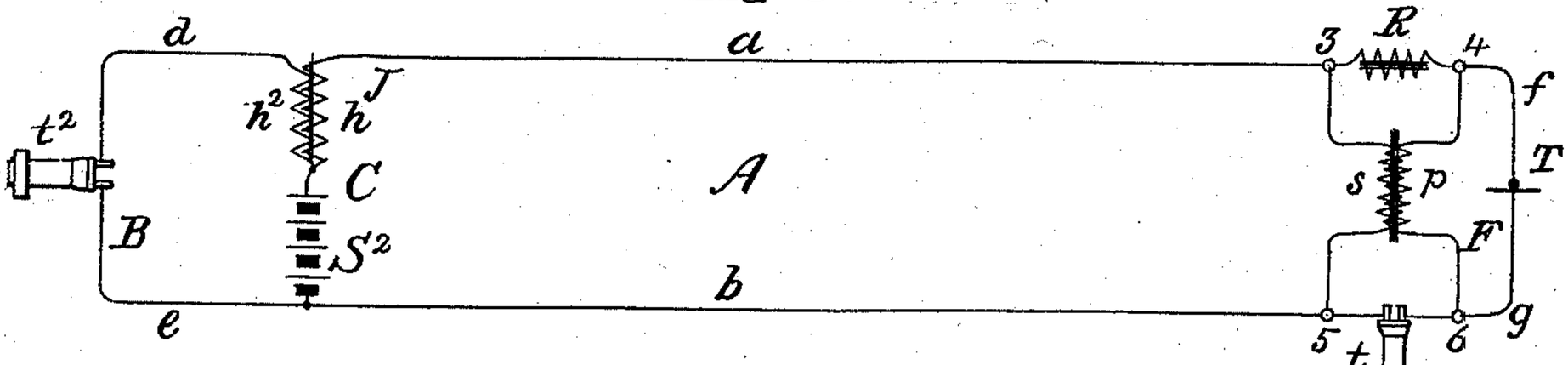


Fig. 4.

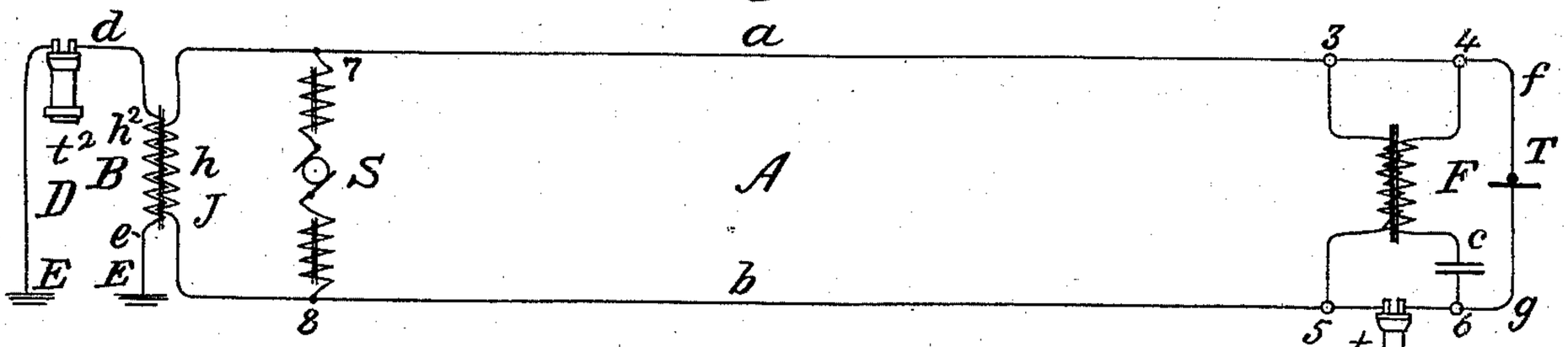
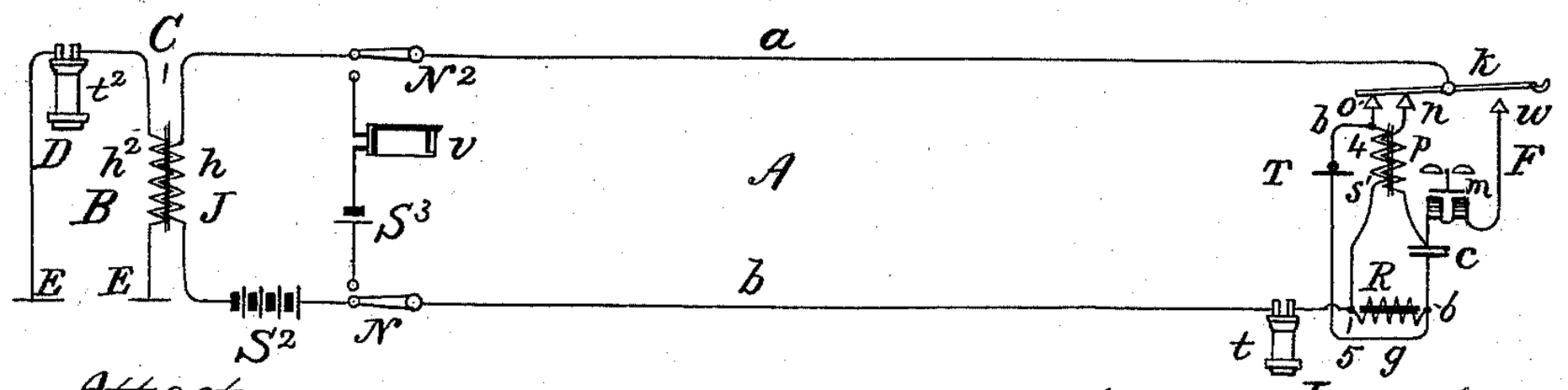


Fig. 5.



Attest.
Geo. T. Smallwood.

Inventor:
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by Poole & Mauro
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UNITED STATES PATENT OFFICE.

THEODORE SPENCER, OF CAMBRIDGE, ASSIGNOR TO THE AMERICAN BELL TELEPHONE COMPANY, OF BOSTON, MASSACHUSETTS.

TELEPHONE-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 505,730, dated September 26, 1893.

Application filed February 20, 1893. Serial No. 463,114. (No model.)

To all whom it may concern:

Be it known that I, THEODORE SPENCER, residing at Cambridge, in the county of Middlesex and State of Massachusetts, have invented certain Improvements in Telephone-Circuits, of which the following is a specification.

My present invention relates to telephone circuits, and especially to that class in which the source of current is in the main circuit, and preferably located at the central station.

The current from the electrical generator traverses the entire circuit, and when a telephonic receiver and a variable resistance or current varying transmitter are connected with said circuit, the operation of the said transmitter by means of words spoken in its vicinity produces waves or undulations in the said current, which acting upon the receiver enable it to reproduce the said spoken words. But for well known and generally accepted reasons, even when the battery is in the main circuit, it is advantageous that the waves produced by the operation shall act upon the main circuit and the distant receiver through the intermediation of an induction coil, and the object of my invention is mainly to enable this mode of transmitter operation to be satisfactorily and efficiently adopted without losing other advantages accruing from the centralization and main circuit connection of the current generator. In the attainment of this object I place the current varying transmitter in the main circuit of a current generator such as a battery or a properly constructed dynamo, and in series with the said transmitter I connect on one or both sides thereof and between it and the said generator an appliance called diversely, an electromagnetic resistance or a retardation or choking coil, of low real or actual resistance, so that it does not materially weaken the line current or obstruct the passage of the same to the transmitter, but having a high co-efficient of self-induction, so that it has a high impedence, and is, it may be said, opaque to, or practically obstructs the passage of undulatory electrical impulses or waves, such as those produced by the operation of the transmitter, these finding in the said choking coil a high apparent resistance. I associate with the transmitter an induction coil, and connect its two helices in independent or separate branches of the main circuit, the resistances of both of the said branches however being high, relatively to that of the transmitter itself. The branch or bridge circuit containing the primary helix of the induction coil, unites points on the direct and return conductors of the main circuit, between the transmitter and the retardation appliance, and as the said appliance prevents the current variations or waves produced by the transmitter from traversing the main circuit, it follows that the said waves expend their energy in varying the electrical condition of the said primary helix, to which they have unrestricted access. But the branch or bridge circuit containing the induction coil secondary, extends between the direct and return conductors of the circuit, connecting therewith at points outside of the retardation appliance, or between said appliance and the source of the steady line and transmitter current; so that the said retardation appliance prevents the variation set up by the transmitter from reaching it. The said primary and secondary helices being however in inductive relation to each other, the variations of the electrical condition of the primary induce corresponding currents to said variations in the secondary, which passing over the main circuit act upon a receiving telephone included therein at any distant station; and operating the same, enable it to reproduce the sounds whereby initially the transmitter was operated. Another function of the retardation coil or coils is therefore to prevent the short circuiting of these corresponding induced currents through the transmitter and a consequent weakening of their effect in the main circuit. The steady current delivered to the main circuit is mainly directed through the transmitter because the resistance of the two coil branches is relatively much higher than that of the said transmitter.

The high resistance of the primary branch may be produced in any desired way; for instance a condenser may be introduced into the said branch, which of course practically makes it discontinuous for steady currents;

or the resistance of the primary coil may itself be high; or it may be normal, and a special resistance serially associated therewith.

In the drawings which form a part of this specification Figure 1 is a diagram indicating a preferred mode of circuit arrangement illustrating the above described principles. Fig. 2 is a diagram of the same arrangement, more completely indicating the electrical connections. Figs. 3 and 4 are diagrams of alternate arrangements and Fig. 5 indicates the application of the invention to a substation apparatus, adapted to operate on the centralized battery exchange system.

In Figs. 1 and 2, A and B represent two main telephone circuits united for telephonic conversation, at a central station C, where is located an electrical generator or source S, supplying both circuits with a steady current for their transmitters. As shown, the said generator is bridged between points 7 and 8 of the united circuits, or in other words is in a section of conductor common to both. In these figures a dynamo is indicated as being employed. A receiving telephone t^2 is at the substation D of circuit B, and the condenser c^2 of said circuit, is merely introduced as an expedient for preventing false busy tests, in a manner well understood. Circuit A extends from station C to substation F, and at the latter station is shown as extending through electro-magnetic resistance appliances, retardation coils, or choking coils R and R^2 by conductors f and g to a variable resistance or current varying telephone transmitter T of any preferred type. These retardation coils have a low actual resistance, and consequently do not materially weaken steady currents or obstruct their passage. With the transmitter T, is associated its induction coil I, having its high resistance secondary helix s, in a branch or bridge circuit x connected between points 3 and 5 on the direct and return conductors a and b respectively, of the main circuit A. No other device is contained in the branch x, which, as shown, is located between the retardation coils and the source of current S. The primary helix p of the induction coil is in a second branch or bridge circuit z parallel to the first, which extends between points 4 and 6 on the two main circuit conductors. A condenser c is also included in this branch. The effect of the high resistance of the secondary helix itself in branch x, and of the presence of the condenser in branch z, is to provide that the major part, that is to say practically all of the current from the generator S, passes through the transmitter T. The receiving telephone at station F may be connected as shown in one of the main conductors of the circuit; or it also may be bridged; it may have two reinforcing coils one in each of the main conductors a and b; or the secondary helix s may be centrally divided, and the receiver introduced between the divisions. The retardation coils R freely admit the steady current of the generator S to the current varying transmitter T. They also prevent the waves in or variations of the said current due to the operation of the said transmitter from passing to the main circuit or distant telephone conductively; and determine electrical changes in the said primary helix corresponding to said variations, which changes through the intermediation of the secondary helix are inductively propagated upon the main circuit and actuate the distant receiving telephone. They also prevent a weakening of the effect upon the main line and distant telephone, of the induced currents developed in the secondary winding, by choking or obstructing the alternative path which otherwise would present itself, through the transmitter. This constructive arrangement of apparatus and circuits has been operated with good results; the induction coil used being a standard transmitter coil with a primary helix having a resistance of half an ohm, and with a secondary helix, having a resistance of one hundred and fifty ohms. The actual resistance of each retardation coil R was varied between ten and twenty ohms, and it was found that their impedences might without detriment vary between apparent resistances of five thousand and ten thousand ohms. The condenser c it was found may vary from one to three microfarads.

Fig. 3 is a modified arrangement presenting however no essential differences. The mode of uniting the two main circuits A and B, and of supplying both with transmitter current from the same source, is that for which Letters Patent No. 474,323 were granted to Hammond V. Hayes May 3, 1892; the said source of current generator is in this instance shown as a voltaic battery S^2 and is placed at the central station C in a section of conductor common to both circuits an induction coil J being interposed between the said generator and one of the conductors of both circuits, and having its two helices or windings h and h^2 included in the said two circuits respectively. In this modification, a repeating induction coil is substituted for the standard transmitter coil; one of the retardation coils R^2 is dispensed with and the receiving telephone is employed in lieu thereof. Satisfactory results were attained by using a repeating coil having a secondary winding of some three or four thousand turns and a resistance of one hundred and five ohms, and whose primary winding consisted of four hundred turns measuring eighty ohms. The condenser being absent, a high resistance primary is requisite. The receiving telephone t in this case is wound to such a resistance as to bring its impedence to a value approximately equal to that of the retardation coil R.

Fig. 4 is another modification which may be found convenient under some conditions. The arrangement in this instance as in Fig. 1, employs an ordinary induction coil and a condenser c, in circuit with the primary. The

retardation coils R are dispensed with, and the receiving telephone *t* at station F raised to an impedence to wave impulses equivalent to two thousand ohms of actual resistance, measurably performs their functions, as well as its own more legitimate one. The circuit A is indicated as being united through a repeating coil J with an earth completed circuit B leading to the distant telephone station D.

In Fig. 5, is illustrated the application of my invention to the circuits of a centralized battery exchange system. A and B represent two exchange telephone circuits entering a central station C from substations D and F respectively. They are shown as being united at C through a repeating coil J. The helix *h* of said coil is connected in circuit A, and the helix h^2 in circuit B. The current generator is in circuit A and located at the central station C. When the circuit is at rest, or not being used for conversation, its connection at the central station is by means of any suitable switches N N^2 through a small calling battery S^3 and annunciator *v*, while at the substation, the telephone *t* being in its support *k*, the circuit is connected through the call bell *m* and condenser *c;* by this means the operation of taking the telephone from the hook closes the circuit of the calling battery, and gives the signal on the annunciator. The remaining connections including the induction coil windings and the retardation coil R, are in accordance with the above stated principles of my invention.

The several diagrams each show two circuits united for through communication; it must however be understood that such a feature is quite non-essential to the invention or its operation, which can be fully embodied and practiced in a single circuit, and furthermore that the electrical generator, whether a dynamo S, or a battery S^2 can in a manner now well understood, be made common to a number of circuits. It must also be understood that, although I have stated certain dimensions, magnitudes and proportions of apparatus, my invention is in no sense restricted to these, which are merely illustrative, and may be widely varied without departing from the spirit of the said invention.

I claim—

1. The combination of a main telephone circuit; a supply current generator included therein; a current varying transmitter included in the circuit at a station thereof; an induction coil therefor, having its primary helix in a branch forming a shunt circuit round the said transmitter and its secondary helix in a like branch forming a shunt round the said primary, both of the said shunts or branches being of high resistance relatively to the transmitter, whereby the major part of the normal current is directed through the said transmitter; and means for preventing the undulations of the main current produced by the operation of the transmitter from propagating themselves over the main circuit conductively, and for enabling the said transmitter to develop such undulations or voice currents in the said main circuit and to act upon receiving telephones included therein, solely through the intermediation of the said induction coil, substantially as specified.

2. The combination of a main telephone circuit; a receiving telephone; a supply current generator; and a variable resistance transmitter all included in the said circuit; an induction coil for the said transmitter, having its primary helix and a condenser in a branch of the main circuit forming a shunt circuit round the said transmitter, and its high resistance secondary helix in a parallel branch forming a shunt round the said primary, whereby substantially the entire main line current is caused to circulate through the said transmitter; and electromagnetic resistances or self induction appliances of low actual resistance, but presenting a high impedence to vibratory or undulatory currents or impulses interposed between the primary and secondary helices, and connected in one or both of the main circuit conductors, whereby the variations or impulses developed in the primary current by the operation of the transmitter, are isolated conductively from the main circuit, and are enabled to generate induced voice currents in the said main circuit through the intermediation of the said induction coil, and for the operation of the said receiver, which in like manner are prevented from passing through the transmitter; substantially as described.

3. The combination of a main telephone circuit; an electrical generator furnishing a steady current included directly therein; the secondary helix of an induction coil bridged between the conductors of the said main circuit, and wound to a high resistance to oppose the passage of the said steady current; a primary helix in inductive relation to said secondary helix included in a second bridge between the said main circuit conductors; a condenser in series with said primary helix in the said bridge to prevent the circulation of the steady generator current through said helix; a telephone transmitter in parallel circuit with the said secondary and primary helices, and adapted to vary its resistance when operated and thereby to set up corresponding variations in the electrical condition of the said parallel primary helix, which variations are inductively transferred to the said secondary helix and main circuit; an electromagnetic resistance or retardation coil opposing a low resistance to the steady generator current, but a high apparent resistance to the telephonic variations of the transmitter, interposed in the main circuit conductors between the primary and secondary helix branches, to prevent the waves produced by the transmitter from passing conductively to the main circuit, and to prevent the induced

waves developed in the secondary from being short-circuited through the transmitter; substantially as described.

4. The combination of a main electric circuit extending between telephone stations; a receiving telephone in said circuit at one of said stations; a generator in said circuit supplying a steady current; a current varying transmitter in said circuit at another of said stations energized by said current, and adapted when operated, to produce undulations or waves therein; a retardation or choking coil of low resistance, but high impedence, in said circuit located between the generator and transmitter, and permitting the free passage to the said transmitter of the said steady current, but obstructing the passage from the said transmitter of the waves produced thereby; an induction coil for the said transmitter, having its primary and secondary helices connected in separate high resistance parallel branches or bridges of said main circuit, the primary branch being between the retardation coil and the said transmitter, and the secondary branch being between the retardation coil and the generator; whereby the said waves due to the operation of the transmitter are enabled to act inductively upon the circuit and to produce corresponding undulations or waves in the main current thereof for the operation of the said receiving telephone, substantially as described.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 8th day of February, 1893.

THEODORE SPENCER.

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