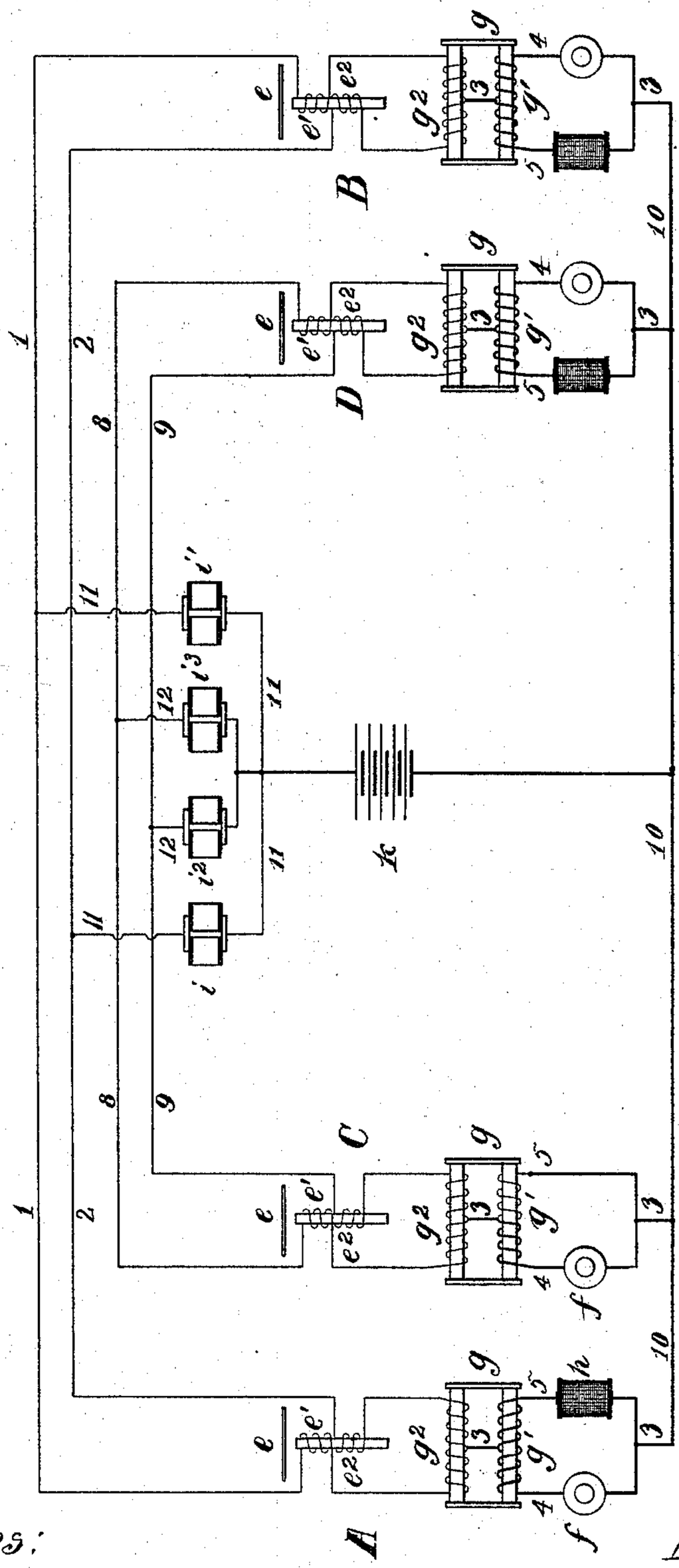
(No Model.)

C. E. SCRIBNER.

TELEPHONE CIRCUIT.

No. 574,005. Patented Dec. 29, 1896.



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UNITED STATES PATENT OFFICE.

CHARLES E. SCRIBNER, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN ELECTRIC COMPANY, OF SAME PLACE.

TELEPHONE-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 574,005, dated December 29, 1896.

Application filed April 20, 1895. Serial No. 546,483. (No model.)

To all whom it may concern:

Be it known that I, CHARLES E. SCRIBNER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Telephone-Circuits, (Case No. 383,) of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to the apparatus and arrangement of circuits for te ephones in which the transmitters are supplied with current over the line-circuit. Its object is to prevent interference or "cross-talk" arising from induced currents in the conductors of the line-circuit.

It has been proposed to supply transmitters at substations of telephone systems with current traversing both conductors of the line-circuit in parallel and returning through a ground connection or a separate return-wire, the telephone-transmitter at the substation, together with the primary winding of the induction-coil, being included in the separate return-circuit branching from the united conductors of the line-circuit. In such a system the undulations of current produced by the transmitter in the ground branch are propagated through the line-circuit, and since these currents are of the same direction in both line conductors the usual expedient of arranging the two conductors of the metallic circuit in proximity, in order that they may annul the inductive effect of each other upon contiguous line conductors, is ineffective in preventing the induction of similar currents in neighboring lines. My invention applies to this type of apparatus and is designed to prevent currents thus induced in the same direction in the two conductors of a circuit from affecting the telephone in its circuit; in other words, to prevent the injurious effects of the induced current in the telephone rather than to prevent the production of such currents in the telephone-line.

In my invention I divide the primary helix of the telephone induction-coil into two equal portions and include one half of the induction-coil, together with the transmitter, in one of two parallel branches of the return-circuit and the other half of the primary helix in the other branch, the normal resistances of these two branches being made approximately equal. The primary helix is placed in the usual inductive relation to the secondary helix of the induction-coil. I prefer, however, to divide this secondary helix also into two portions, from a point intermediate of which portions the return-circuit is branched. The receiving-telephone should also be provided with two magnet-coils included in the two sides of the line-circuit, respectively.

When the apparatus is thus arranged, telephonic or voice currents circulating in the metallic line-circuit traverse the secondary helix of the induction-coil and the two magnets of the receiving-telephone in the proper direction to magnetize the telephone and reproduce the transmitted sounds therein. The supply-current flowing over the two sides of the line-circuit in parallel does not affect these instruments. It divides into equal portions, which traverse the two halves of the primary helix in opposite directions, leaving the core neutral; but when the resistance of the transmitter is altered the distribution of current through the divisions of the primary helix is altered and a resultant magnetization of the core is produced, which creates in the secondary helix a current which traverses the line-circuit in a manner well understood. When, however, the conductors of the line-circuit are subjected to the inductive action of adjacent circuits, the currents thus created in the two conductors find circuit through the magnets of the receiving-telephone and the two divisions of the primary helix in reverse directions, so that they annul each other's magnetic effect upon the cores of these instruments. The receiving-telephone thus remains unaffected by the currents from an extraneous source.

I have illustrated my invention in the accompanying diagram, which represents four substations equipped with the apparatus of my invention supplied with current from a centrally-located battery and having a common ground return-circuit. The different stations are designated A, B, C, and D. At each station is located a receiving-telephone

e, a transmitting-telephone *f*, and an induction-coil *g*, conventionally represented as a closed-circuit transformer. Various modes of arranging the apparatus are shown at the different substations. At station A the receiving-telephone *e* carries two coils e' e^2, which are included in the line conductors 1 and 2, respectively, to the substation apparatus. The line conductors are united through the secondary helix g^2 of induction-coil *g*. From the central point of this helix g^2 a ground branch 3 is taken. This ground branch is connected with the central point of the primary helix g' of the induction-coil, whose free terminals are grounded through the transmitting-telephone *f* and the resistance-coil *h*, respectively. That is, the ground branch 3 is divided into two parallel portions 4 and 5, one of which includes one half of the helix g' and the transmitting-telephone *f* and the other the remaining portion of the helix g' and the resistance-coil *h*.

At station C the apparatus is substantially the same, excepting that the resistance-coil *h* in the branch 5 is omitted, the portion of the primary helix g' included in that circuit being made of sufficiently high resistance to equal that of the entire branch 4.

The substations A and B are united by line conductors 1 and 2 in a metallic circuit. Stations C and D are also in a metallic circuit 8 9. A return-conductor 10 extends to all the substations in common. Between the conductors 1 2 is connected a bridge-wire 11, which includes two impedance-coils *i* and i'. A bridge 12 is likewise connected across the circuit 8 9, including other impedance-coils i^2 and i^3. A battery *k*, which is designed to serve as a common source of current-supply for the different substations, has one of its terminals connected with the common return-conductor 10, its other terminal being branched to the different conductors 11 and 12 at points intermediate of the impedance-coils in them.

The line conductors 1 2 and 8 9 may be assumed to be arranged in close proximity to each other, as in a cable, which results in the induction of voice-currents from one circuit into another.

The normal operation of the system in telephonic communication between two connected substations may first be traced. Current from battery *k* finds circuit through the impedance-coils *i* and i', which should be of comparatively low resistance, over line conductors 1 2 in parallel to the substation, as A, where it flows through the two magnet-coils *e* e^2 of the receiving-telephone, through the different portions of the secondary winding g^2 of the induction-coil, thence through conductor 3, dividing into equal portions through the branches 4 5, and finally to the return-conductor 10. The currents through the magnet-coils and those through the two portions of the secondary winding g^2 and the primary winding g' of the induction-coil are in such direction as to annul each other's magnetic effects, leaving the cores neutral. If now the resistance of the transmitting-telephone *f* be diminished by the impact of a sound-wave upon it, current is diverted from the branch 5 to branch 4, whereby the magnetic effect of one half of helix g' is increased and that of the other half is decreased. The neutral relation of these helices is disturbed and a resultant magnetization is created in the core, which produces an electromotive force in helix g^2. Current is thus caused to flow through the line conductors 1 2 to station B through the magnets e' e^2 of the receiving-telephone and through the secondary winding of the induction-coil. It will be observed that this current flows through the coils e' e^2 in such direction that they coöperate in magnetizing or demagnetizing the core. Hence the receiving-telephone at station B responds to the current thus originated at station A. The succeeding increase of resistance of transmitter *f* at station A now diverts current from branch 4 and through branch 5. The resultant magnetization of the core of coil *g* is now in the reverse direction, whereby a reverse current is induced in the line-circuit and a reverse effect is produced on the receiving-telephone at station B. Thus a succession of sound-waves impinging upon the diaphragm of transmitter *f* creates in the metallic circuit 1 2 and through the receiving-telephones at the two stations a telephonic current of alternating character.

The variation of resistance in the transmitter of course results in a variation in the supply-current over conductors 1 2 and through the return branch 3 and the return-circuit 10. The supply-current is hence of a slightly undulatory character, the undulations corresponding also to the sound-waves which strike the transmitter. These undulations produce no effect upon the receiving-telephone at the distant station, however, since they traverse both line conductors 1 and 2 in the same direction and find circuit through the magnet-coils of the receiving-telephone to return conductor 10 in the proper direction to annul each other and leave the receiver-magnet unaffected.

Considering now the action of circuits in inductive relation upon each other, it will be obvious that the alternating telephonic currents—those which are relied upon in transmitting conversation between substations—do not affect neighboring circuits. These currents circulate in each metallic circuit, being in opposite directions in the two limbs of the metallic circuit, so that the resultant effect upon adjacent conductors is *nil*. The undulations propagated through the two line conductors of the metallic circuit in the same direction, however, induce in the neighboring metallic circuits other currents which flow along the two line conductors of each circuit in the same direction. These induced currents reaching a substation traverse the magnet-coils of the receiving-telephone and the

windings of the induction-coil in the proper direction to leave their cores unaffected, as before traced at length. In short, the operation of the telephonic appliances at a substation may be regarded as resulting in three distinct currents in each line-circuit—a continuous current for supplying the transmitter, an undulating current produced in the line conductors coupled in parallel, and an alternating telephonic current circulating in the complete metallic circuit—traversing the line conductors in opposite directions. The substation apparatus at the distant station is undisturbed by both the constant supply-current and the undulating current, whether this latter arises in the same circuit from variations of its resistance or whether it be due to the inductive action of adjacent circuits, the receiving-telephone responding only to the alternating telephonic currents circulating in the line and reproducing the sounds represented by that current.

Various departures may be made from the form of my invention which I have herein described, and it may be adapted to other uses than in connection with telephone-circuits.

I claim, broadly, as new—

1. The combination in a telephone-circuit, of an induction-coil, a telephone-transmitter in a closed circuit with the primary helix thereof, and a supply-circuit connected with the central point of said primary helix, the secondary helix of the induction-coil being included in circuit with a receiving-telephone, whereby variations of current in the supply-circuit are prevented from producing undulations of current in the secondary helix.

2. The combination in a telephone-circuit, of an induction-coil having its primary helix in two portions, adapted when traversed serially by a current to magnetize the core of the coil, a current-supply circuit divided into two parallel branches, each branch including one of the portions of said primary helix, a transmitting-telephone in one of the branches, the normal resistances in the two branches being approximately equal, and a receiving-telephone in circuit with the secondary helix of the induction-coil.

3. The combination with a current-supply circuit comprising the two line conductors of a telephone-line grouped in parallel, and a single return-circuit, the return-circuit being divided at one point into two parallel branches, of a receiving-telephone having two magnet-coils in the different line conductors, respectively, arranged to respond to current circulating in the line-circuit, an induction-coil having its secondary helix in the line-circuit and its primary helix divided into two portions included respectively in the two branches of the return-circuit, a transmitting-telephone in one of said branches, the normal resistances of the branches being approximately equal, the two portions of the primary helix being so related as to direction of current through them that equal currents in the same direction through both branches neutralize each other's effects, whereby variations in the supply-current are prevented from affecting the receiving-telephone.

4. The combination with a metallic-circuit telephone-line, of a receiving-telephone at each terminal station thereof having a magnet-coil in each line conductor, the magnet-coils being arranged to neutralize each other when traversed by currents of the same direction in the line conductors, a supply-circuit comprising the two line conductors grouped in parallel and a single return-conductor, an induction-coil at each station having its secondary helix in the line-circuit and having its primary helix divided into two portions in different parallel branches of the return-circuit, and a transmitting-telephone in one of the branches, the normal resistances of the branches being approximately equal, substantially as described.

5. The combination with a telephone-circuit and a supply-circuit for the transmitting-telephone thereof, of an induction-coil having one of its windings included in the telephone-circuit and the other of its windings in the supply-circuit or a portion thereof, a transmitting-telephone in the supply-circuit, and circuit connections about said transmitting-telephone completing a local circuit wherein the transmitting-telephone may create variations of current strength, said local circuit being in inductive connection with said telephone-line, the winding of the induction-coil in the supply-circuit being adapted to oppose the currents in the telephone-circuit created by current in said local circuit, substantially as described.

In witness whereof I hereunto subscribe my name this 17th day of April, A. D. 1895.

CHARLES E. SCRIBNER.

Witnesses:

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