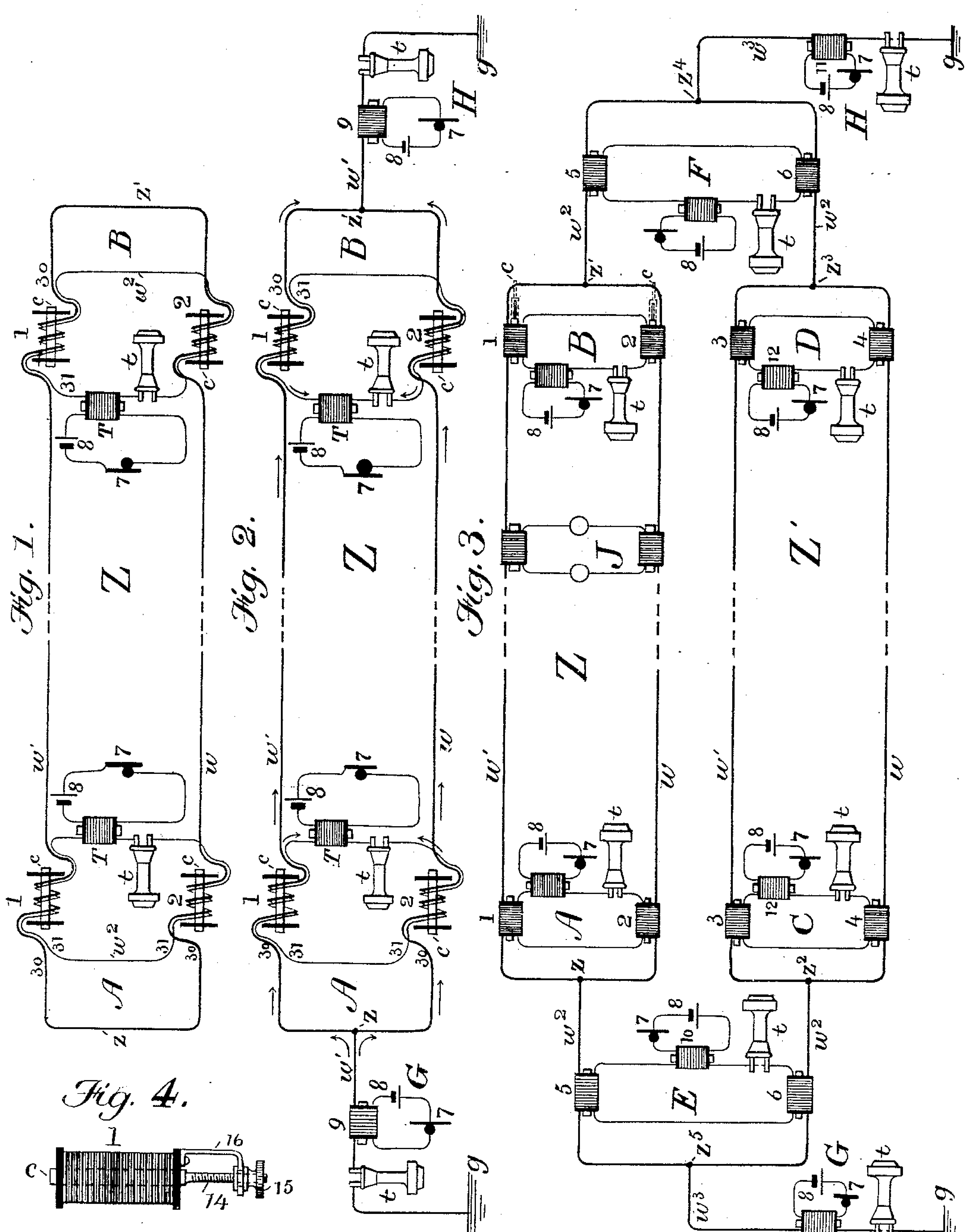
(No Model.)

J. A. BARRETT.

TELEPHONE CIRCUIT.

No. 350,715. Patented Oct. 12, 1886.

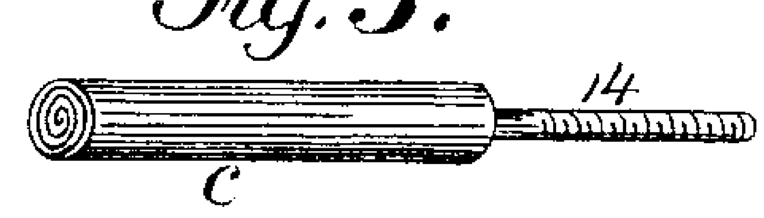


Witnesses.

Geo Willis Pierce

Geo. H. E. Trouvelot.

Fig. 5.



Inventor.

John A. Barrett.

N. PETERS, Photo-Lithographer, Washington, D. C.

UNITED STATES PATENT OFFICE.

JOHN A. BARRETT, OF BROOKLYN, ASSIGNOR TO THE AMERICAN TELEPHONE AND TELEGRAPH COMPANY, OF NEW YORK, N. Y.

TELEPHONE-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 350,715, dated October 12, 1886.

Application filed July 19, 1886. Serial No. 208,463. (No model.)

To all whom it may concern:

Be it known that I, JOHN A. BARRETT, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Telephone-Circuits, of which the following is a specification.

This invention is an improvement in telephone circuits and apparatus, whereby I am enabled to avail myself of the immunity from inductive disturbance inherent in the use of a parallel metallic return-circuit, retaining at the same time the ability to transmit two simultaneous messages over the said metallic circuit in either direction, so that, although the cost of one metallic circuit includes that of two complete wires, the additional outlay is substantially neutralized by the ability to send two messages simultaneously over the said metallic circuit; but one, however, of these communications participates in the benefits of the metallic circuit.

Furthermore, the principle of the invention is not restricted to a single metallic circuit, but may be carried out to an indefinite extent, as hereinafter described. It is well-known that when two electrical conductors are placed in proximity variations of the electrical condition of one will develop inductive electrical currents in the other more or less accentuated, according to the character of the initial variations and degree of proximity of the two conductors in question. This phenomenon is very pronounced in the case of telephone-circuits, which, by reason of the extreme sensitiveness of the receiving-instrument, are oftentimes greatly troubled by adverse currents induced by parallel telegraphic or telephonic circuits, which act both to confuse and drown out the desired sounds, and also to reproduce upon any individual telephonic circuit messages which are passing upon the other lines. A well-known expedient frequently adopted to neutralize these adverse influences is to substitute a return-wire for the ordinary ground-terminals or ground-return of the telephone-circuit. This plan, to give satisfaction, requires that both direct and return wire must be substantially equidistant from the source or sources of disturbance. The chief disadvantage which this plan presents is the greatly-increased cost, which, it is evident, is nearly double that of a single-line circuit or system of circuits. For this reason it has proved very desirable that some mode or arrangement of circuits should be obtained whereby the advantages of the metallic circuit should be retained, and whereby its chief disadvantage recited above, should be materially curtailed.

To provide such an arrangement of circuits and apparatus is the main object of my invention. Heretofore and prior to my invention the only way devised for the attainment of this object has been to connect the metallic-circuit transmitting and receiving instruments in the bridge-wire of a Wheatstone's bridge arrangement of circuits, effecting a balance by suitably-proportioned resistances included in the two branches between the said bridge-wire and the union of the direct and return wires, and by including a second set of telegraphic or telephonic instruments in earth branches at both ends of the circuit. In this arrangement the two earth-branch instruments work respondently, the bridge-wire instruments also being adjusted to work with one another only, and being irresponsive to the action of the earth-branch instruments. This principle of operation is capable of considerable extension in practice. For example, the two wires of two distinct metallic circuits may be utilized as the direct and return conductors of a compound metallic circuit having instruments in a bridge-wire, in which case the earth branch would be extended from the junction-point of the two metallic circuits, and such a system may be indefinitely carried out.

So far as I am aware, Letters Patent of the United States No. 287,288, issued October 23, 1883, to Frank Jacob, fully exemplify the state of the art embodying the principle of operation hereinbefore described.

My invention is an improvement in the said art and in the appliances required in operating the same. Experience has demonstrated that the direct-operating-bridge arrangement has certain defects which by my invention are overcome. A considerable portion of the energy of the current traversing the circuit is dissipated or transformed in the circuit itself in overcoming the balancing-resistances, and the operating-current is necessarily so subdivided that its action upon the receiving-magnets is of an extremely limited nature.

My invention, broadly stated, consists in bringing the metallic or double-wire instruments at the terminal stations into inductive relation by means of converting or repeating induction-coils with both sides of the circuit, instead of connecting them directly with the said circuit by means of a bridge-wire. The currents traversing the metallic circuit are thus economized, inasmuch as they are only required to traverse a direct circuit, while the accompanying currents, which are initiated in the earth branch at either terminal station to actuate the corresponding receiving-instrument in the distant earth branch, cannot affect the intermediate double-wire instruments, as the current generated by the said earth-branch transmitters at any given instant acts upon both sides of the double-wire receivers alike, the current induced in one converting-coil being opposite in direction to that induced in the other at the same instant, so that its effect is thus neutralized by its own action.

I provide a double-wire-line circuit, and at the terminal stations I include in each wire of the circuit an induction-coil preferably wound with two insulated wires side by side, one of which wires is directly in circuit with the double-wire line, while the other is connected in circuit with the secondary helix of a telephone-transmitter and with the coil of a telephone-receiver. Thus messages from a distant station reach the receiver by means of induction through the converting-coils, one of which is in the direct and the other in the return wire, while messages spoken in the transmitter develop currents in the secondary circuit of the induction coil thereof, and these again by induction develop tertiary currents of coincident direction with one another in both converting-coils simultaneously, which currents, being of like direction, re-enforce one another and traverse the line to act through like converters upon the distant receiver. To a point of the metallic circuit at each terminal station, substantially equidistant from the converting-coils, I attach an earth branch, including the usual telephone-instruments. Telephonic currents developed in the transmitters at either terminal station in the earth branches will traverse both direct and return wire in the same direction—that is, in relation to any intermediate point or appliance the current in both lines will be at any given moment positive or negative; hence, while the receiving-telephone in the distant earth branch will readily respond to their action the intermediate instruments will be totally irresponsive, for reasons hereinbefore stated.

In the drawings illustrating this specification, Figure 1 is a diagram of the plan I adopt of inductively connecting the metallic-circuit instruments. Fig. 2 is a diagram showing the combined double-wire and earth-branch system arranged in accordance with my invention. Fig. 3 shows diagrammatically the same invention applied in multiple. Fig. 4 is a detail of the converting induction-coil, and Fig. 5 a detail of the magnetic core thereof.

In Fig. 1, Z represents a single metallic or double-wire telephone-circuit extending between two stations, A and B, *w* and *w'* being the direct and return conductors thereof. At each station are two converting induction-coils, 1 and 2, the two insulating-wires of which (being preferably of substantially identical gage and length) are wound together, so that each conductor is in close inductive proximity to the other throughout its entire length. One of the conductors, 30, of the converting-coils is included at each station, as shown, in the circuit of the direct wires *w* and *w'*, so that the said conductors of each coil are virtually placed in direct circuit serially with the said line. The other conducting-wires, 31, of the said coils are joined up in a local or home circuit comprising the receiving or magneto telephone *t* and the secondary helix of the transmitting-telephone induction-coil T, the latter being operated in the usual manner through the intermediation of the primary helix by the transmitter 7 and battery 8. The local circuit may be traced as follows: wire 31 of converting-coil 1, secondary transmitter-coil T, receiving-telephone *t*, wire 31 of converting-coil 2, and thence by conductor w^2 back to the starting-point. The route of the main circuit in like manner may be traced from an arbitrary starting-point, *z*, at station A, through wire 30 of converting-coil 2, line-wire *w*, through the converting-coils 1 and 2 at station B, and back *via* line-wire *w'* and through coil 1 at station A, back to the point *z*. Each converting-coil is provided with a soft-iron magnetic core, which is preferably adjustable with respect to the extent of its insertion in the helix-spool, (for a purpose which I shall hereinafter describe,) as shown in Fig. 4, in which a thumb-nut, 15, is mounted upon a fixed standard, 16, by means of two flanges, which embrace the forearm of the said standard. The core is provided with a screw-extension, 14, which passes through the standard-arm, and is fitted to the said nut, whereby when the nut is turned the screw, with the magnetic core attached thereto, is advanced into or withdrawn from the interior of the helix. By using a micrometer or differential screw the adjustment may be effected with any requisite degree of fineness.

In Fig. 2 I show a metallic or wire return-circuit, Z, with its appliances similar in every respect to the circuit and arrangement described in Fig. 1, but with the addition of an earth-branch extension-circuit at both terminal stations. This branch *w'* is at both ends united to the double-wire circuit at a point, *z* or *z'*, practically equidistant from the two converting-coils 1 and 2, and passes through the regular telephone-instruments to earth at *g*. This earth-branch extension may of course be constructed of any convenient length extending to the stations G and H, which may be located at a considerable distance from the points z and z'. The telephone-instruments shown at each of these stations G and H consist in this case of a receiving-telephone, t, and a transmitter, 7, in a primary circuit including a battery, 8, connected with the branch line w' through its induction-coil 9. The instruments in both terminal branches are alike, and a description of one will thus serve for both. I have found in practice that stations A and B may freely and readily exchange oral communications without affecting the instruments at stations G and H, and that G and H may in like manner communicate without interfering in any way with messages which may simultaneously be in course of transmission between A and B. Considering, first, the case of the stations A and B. the secondary electrical current generated in the secondary coils T of the transmitters traverse the conductors 31 of the converting-coils 1 and 2, setting up corresponding induced currents therein, which currents, being at any given moment of similar sign in the two coils 1 and 2, re enforce one another and pass over the line-wires w and w' to the distant station B, where, acting inductively through the converting-coils 1 and 2, they affect the receiver t, reproducing the message transmitted at station A. The two converting-coils at the transmitting-station, whether A or B, may thus be unitedly regarded as the source of undulatory electric energy for the double-wire circuit, and may be compared to two separate cells or sections of voltaic battery joined up serially, so as to re-enforce one another. They are therefore enabled to act effectively through the corresponding converting-coils in the metallic circuit at the distant station upon the receiver there, but have no effect upon the earth-branch receiver, because the currents originated in the metallic circuit (as a metallic circuit) continue to circulate therein without reference to the earth branches at either end of the double line. Considering, secondly, the case of messages transmitted from the instruments in the ground-branch stations G or H, any communication originating, for instance, at the station G will be transmitted by the instrument 7, and will of course initiate secondary currents in the coil 9. These voice-currents upon arriving at the junction-point z divide, as indicated by the arrows, and proceed partly upon the wire w and partly upon the wire w' to the distant station H. Arriving at the point z', they reunite and affect the instruments included in the earth branch at station H, reproducing the original messages in the receiver t. The receivers at A and B do not respond to these voice-currents, because they pass through the wires 30 of the converting-coils 1 and 2 at both A and B with equal but opposite effect, the current induced in the wire 31 of 1 being opposite to that induced in the wire 31 of 2. The resultant effect, therefore, in the metallic circuit receivers is an absolute neutrality or nullity. This neutrality is, however, contingent upon the equality in resistance and inductive power of the corresponding converting-coils 1 and 2. They must be wound as nearly as possible with equal amounts of insulated wire of the same gage, and an exact balance of inductive power is effected by varying the extent to which two magnetic cores, c, are inserted into their respective spools. I have found that by ordinary manual variation alone a substantial balance can readily be effected. By adopting a screw-adjustment, using, preferably, a micrometer or differential screw, as in Fig. 4, the balance can be brought with great ease to a perfect exactness; and I have also found that a most efficiently-operating core can be made by rolling up soft sheet-iron into a circular form, as indicated in Fig. 5.

Fig. 3 shows the extension or elaboration of the principles involved. Two separate double-wire circuits, Z and Z', are employed, each corresponding in every feature to the circuit described as Z in Fig. 2. These are united at each end by a loop-wire, w^2, provided on each of its arms with a converting-coil, 5 and 6. These coils bring into inductive relation to the line additional sets or stations of telephonic apparatus, E and F, and the wires w and w' of the circuit Z serve together as one side of the line-circuit for these additional stations, while the wires w and w' of the circuit Z' serve in like manner unitedly for the other side of said line. Earth branches w^3 at both ends may again be attached to the electrical centers z^4 and z^5 of both of the above described loops and contain the stations G and H. It will be seen that this principle of connection is capable of indefinite expansion. At station B in Fig. 3 the adjustability of the converting-coil cores c is indicated by dotted lines.

Way-stations may readily be connected with any of the double-wire circuits, as shown at J, the connections being arranged in precisely similar manner to the terminal double-wire stations.

The usual signaling appliances are of course in practice combined with the above system in a manner well understood.

Having now described my invention, I claim—

1. The combination, with a metallic or double-wire main circuit, of local circuits at two or more stations located upon the said main circuit, the said local circuits including telephone-instruments, and being connected with the main circuit by means of induction-coils, substantially as specified herein.

2. The combination, substantially as hereinbefore described, of a metallic or double-line main circuit and local telephone-circuits at the stations located upon the said main circuit, each of the said local circuits including telephones, and being connected with the said main circuit by means of induction-coils, one of the said coils being included in the outgoing and the other in the incoming line-wire of the said metallic circuit.

3. The combination, at a telephone-station,

of a metallic or double-wire main circuit, a local circuit, including telephones, and two induction-coils, one wire of both of the said induction-coils being included in the said local circuit, and the other wire of the said coils being included one in each line-wire of the double-wire circuit, as and for the purposes set forth.

4. The combination, in a system of telephonic communication, of a metallic or double parallel-line circuit extending between two or more stations, of local circuits, including telephone apparatus, connected by means of induction-coils with both sides of the said double-line main circuit, and earth branches, including telephones, connected with the said metallic circuits at the terminal stations thereof and at a point between the said induction-coils, whereby the stations inductively connected with the double-line circuit may be enabled to communicate with one another to the exclusion of the earth-branch stations, and vice versa, as hereinbefore described.

5. In a system of telephonic communication, a metallic or double parallel-line main circuit, a series of local circuits, each including telephones, induction-coils, two for each local circuit, connecting the said local circuits with both sides of the main circuit, one wire of each coil of a pair being included in the local circuit, and the remaining wire of the two coils being interposed, one in each line of the metallic circuit, and earth branch circuits, with telephones included therein, united to the said metallic circuits at the terminal stations thereof and at a point substantially equidistant from both induction-coils, substantially as and for the purposes hereinbefore described.

6. The combination, substantially as hereinbefore described, of a main metallic or double-line circuit, a series of local circuits, each including telephones, and each connected by means of induction-coils with both sides of the double-line circuit, earth branches connected with the said metallic circuit at the termini thereof and at a point thereof between the said induction-coils, and adjusting devices whereby the inductive power of the said coils may be varied, so that currents passing between the earth branches may be accurately balanced in the two induction-coils, and so that their effect upon the local-circuit receiving-instruments may be neutral.

7. The combination, in a system of telephonic communication, of a metallic or double parallel-line circuit, earth branches, including telephone apparatus, connected with the metallic circuit at both termini, a series of local circuits including telephones, and a pair of induction-coils for each local circuit, whereby the said local circuits are inductively connected with both sides of the metallic circuit, as herein described, the said induction-coils having their two wires wound together being of approximately equal resistance and inductive power, and being provided with adjustable cores, whereby communication may be individually maintained between the several local-circuit instruments and between the earth-branch instruments, substantially as set forth.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, this 17th day of July, 1886.

JOHN A. BARRETT.

Witnesses:

GEO. WILLIS PIERCE,

THOS. D. LOCKWOOD.