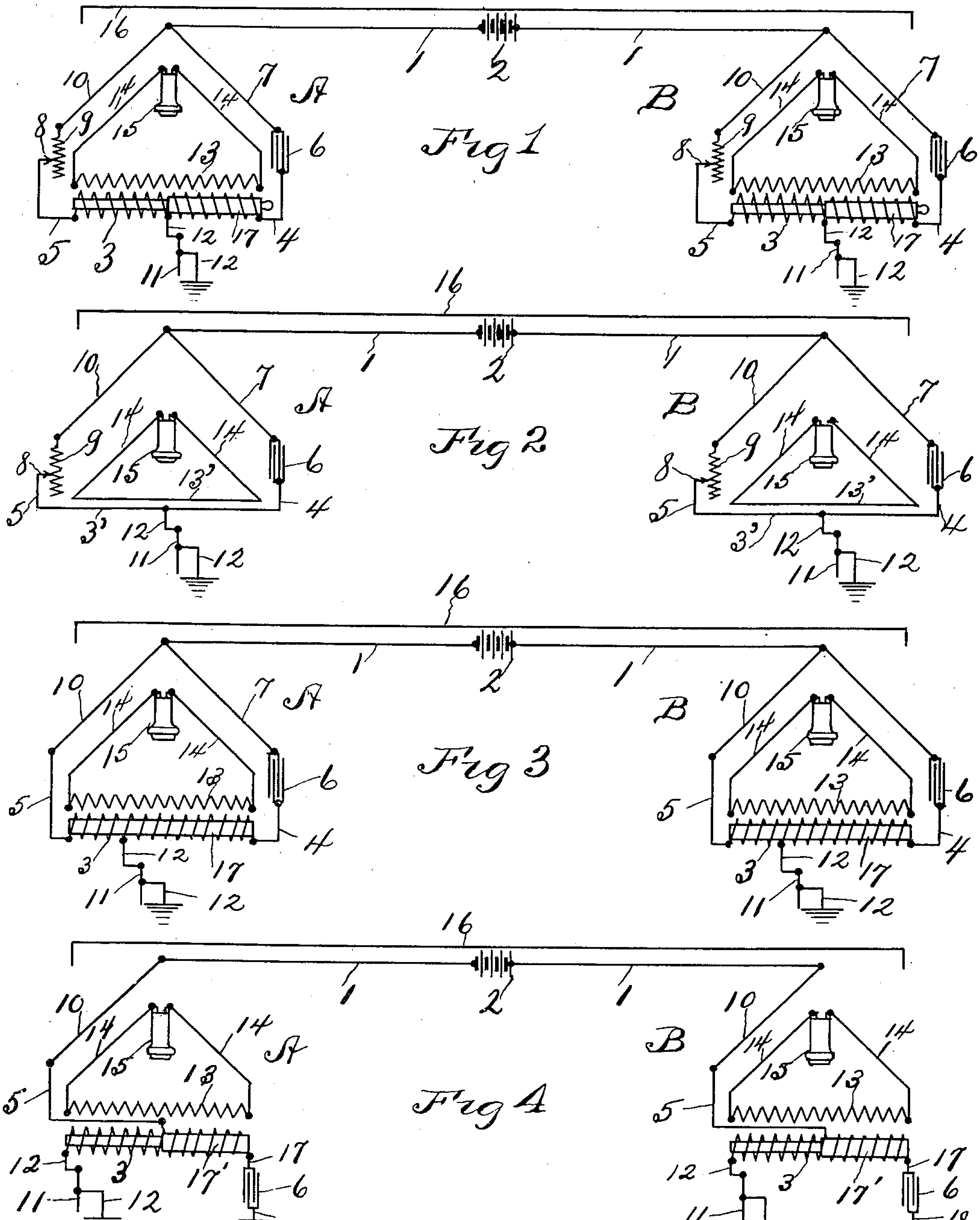
W. CONDON & A. BARRETT.

ANTI-INDUCTION METHOD FOR TELEPHONE SYSTEMS.

APPLICATION FILED MAY 27, 1907.

910,176. Patented Jan. 19, 1909.

2 SHEETS—SHEET 1.



WITNESSES:
E. B. House
E. A. Cahill

William Condon
Albert Barrett
INVENTORS
BY
Warren D. House
Their ATTORNEY.

W. CONDON & A. BARRETT.

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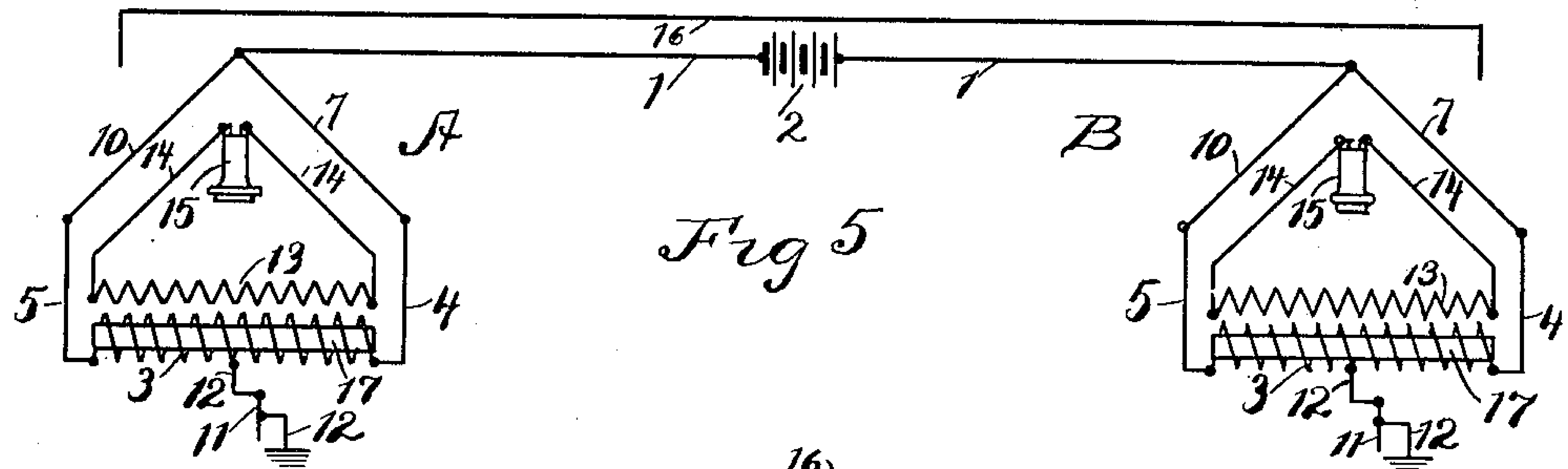

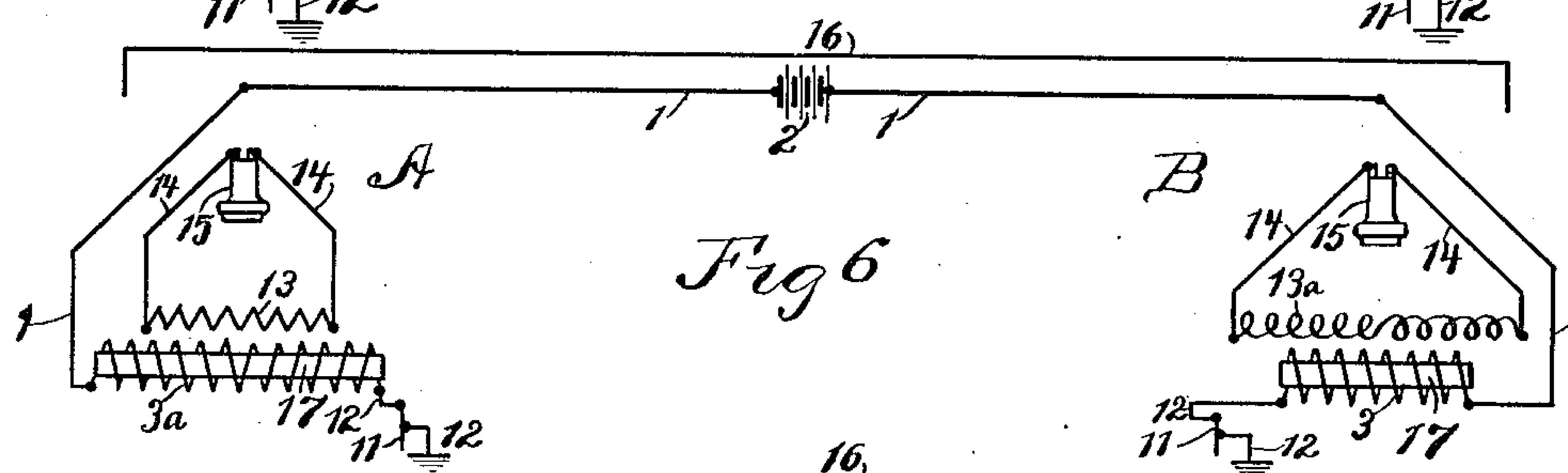

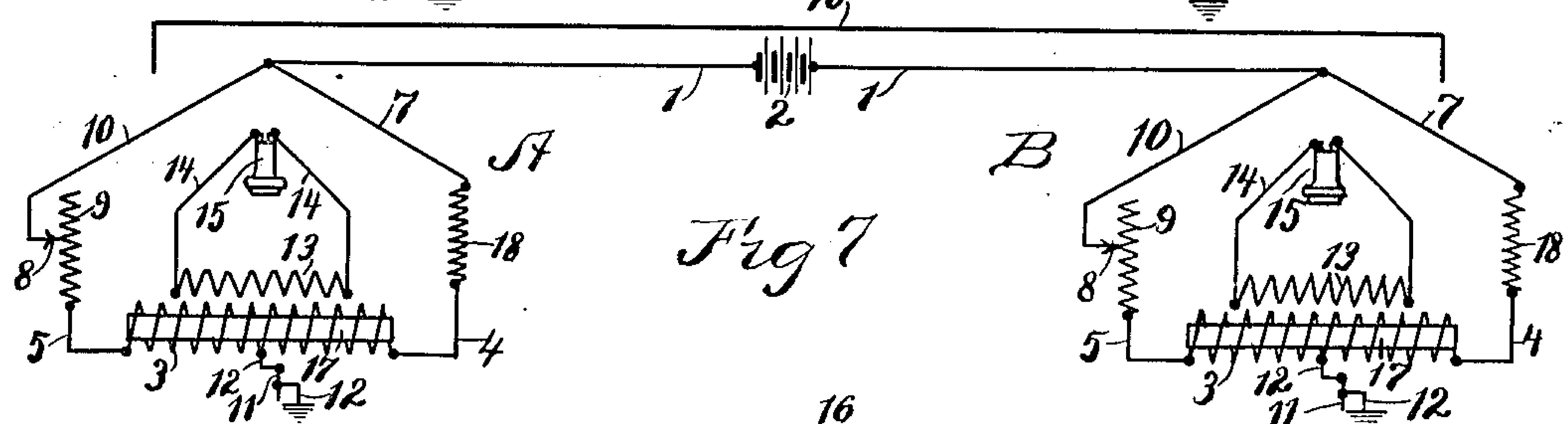

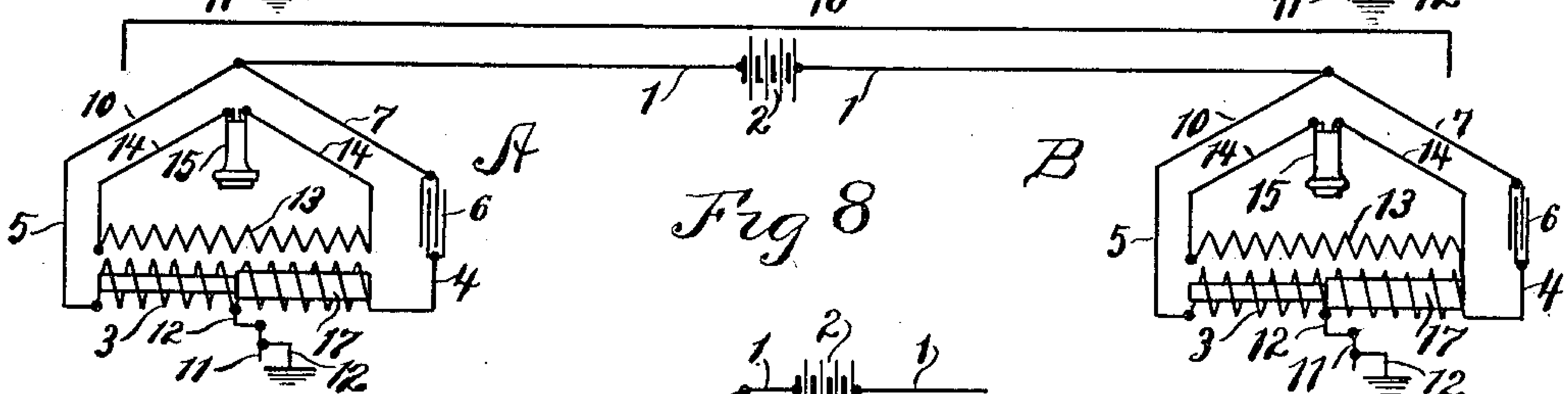

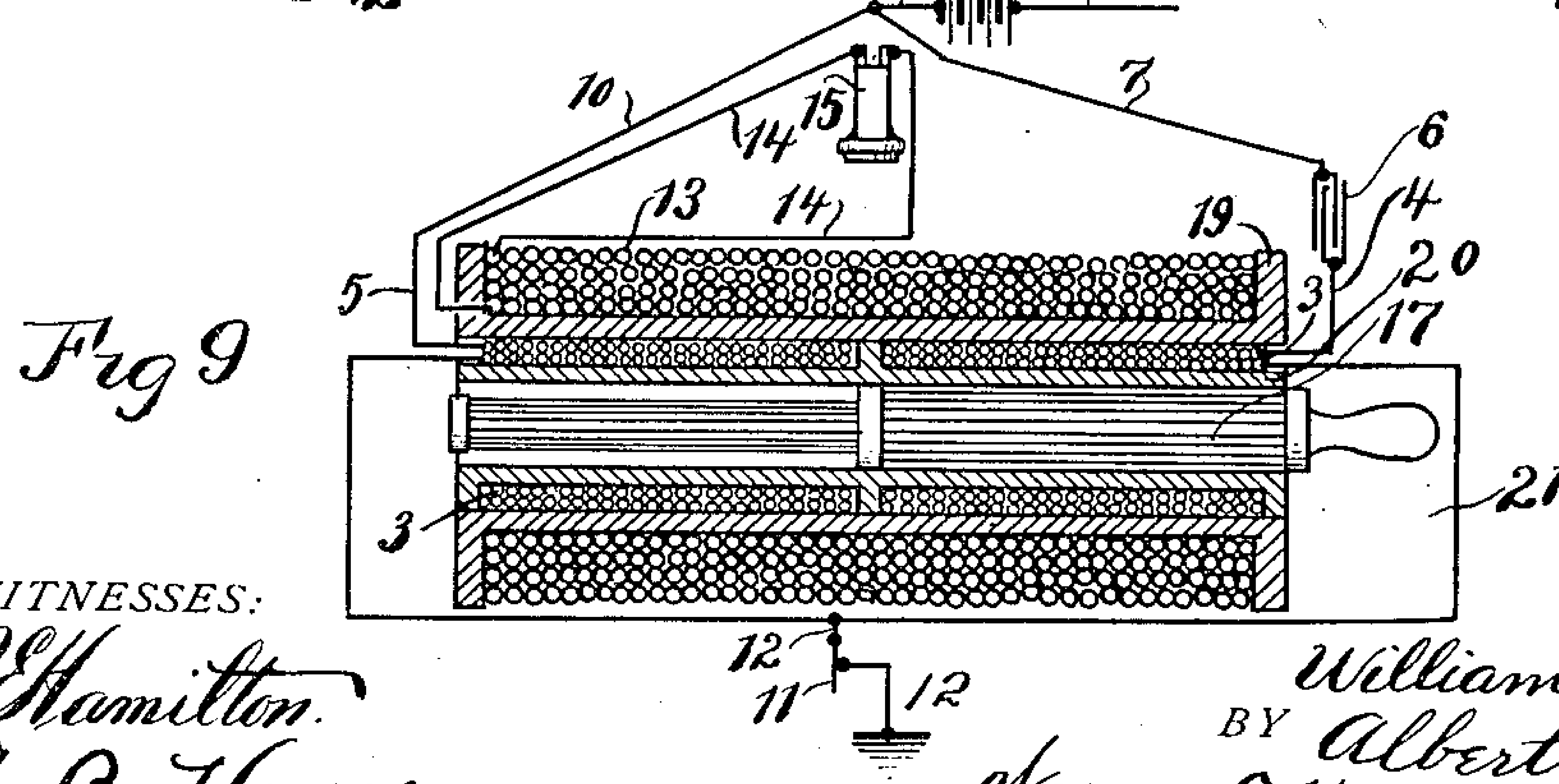

WITNESSES:

R. E. Hamilton.

E. B. House

INVENTORS

William Condon

Albert Barrett

BY Warren D. House,

Their ATTORNEY.

UNITED STATES PATENT OFFICE.

WILLIAM CONDON AND ALBERT BARRETT, OF KANSAS CITY, MISSOURI.

ANTI-INDUCTION METHOD FOR TELEPHONE SYSTEMS.

No. 910,176. Specification of Letters Patent. Patented Jan. 19, 1909.

Application filed May 27, 1907. Serial No. 375,977.

To all whom it may concern:

Be it known that we, WILLIAM CONDON and ALBERT BARRETT, citizens of the United States, residing at Kansas City, in the county of Jackson and State of Missouri, have invented certain new and useful Improvements in Anti-Induction Methods for Telephone Systems, of which the following is a specification.

Our invention relates to an improved method for preventing in telephone systems disturbances due to induction.

Our invention is particularly adapted for telephone systems in which the transmitters and a battery are located in a primary line circuit, the receivers being located in secondary circuits inductively related to the primary circuit.

The object of our invention is to eliminate disturbances from the secondary circuits due to disturbances set up in the primary circuit by induction.

Our invention provides a method consisting in employing the disturbing currents traversing the primary circuit to induce in the secondary circuit currents contrary in direction but substantially equal in strength, and which therefore nullify each other.

In the preferred form of our invention we employ direct currents in the transmitting or primary circuit, such currents as are generated by a battery.

We have found that the telephonic currents induced in the secondary circuit, which circuit contains the receiving telephone, are much stronger than the currents induced in the secondary circuit by the disturbing currents in the primary circuit. Such disturbing currents in the primary circuit are usually alternating currents due to induction from foreign sources, such as electric light or power currents.

We have found that by subjecting two portions of the receiving circuit to the opposite inductive action of the alternating disturbing and the direct telephonic currents which traverse the primary circuit, that so far as can be detected with the ear, the disturbing currents may be made to neutralize each other in the secondary circuit, while at the same time the sounds caused in the receiver by the telephonic currents are very distinct.

We have found by experience that the opposite inductive action exerted by the telephonic and other currents upon the two portions of the secondary or receiving circuit may be so proportioned that the telephonic currents induced in the secondary circuit, by reason of the inductive action on one portion of the circuit being greater than the inductive action upon the other portion of the circuit, will produce in the receiver good talk of considerable volume and unaccompanied by any other sounds due to induction. We have obtained this result in very noisy circuits in which the ground was employed as part of the primary circuit.

We have found that if an ordinary condenser be connected in series in the primary transmitting circuit that the induced telephonic currents set up by the condenser will themselves have feeble inductive action upon another circuit compared with the inductive action of the original direct telephonic currents. On the other hand, we have found that the currents induced in the condenser by the disturbing alternating currents induced in the primary circuit are capable of inducing in the secondary circuit currents very near equal in strength to the currents induced in the secondary circuit by the original disturbing currents.

By the employment of the principles just stated in the preferred form of our invention, we have obtained on a very noisy grounded circuit remarkably loud and clear talk with an entire absence of other sounds due to disturbing currents traversing the line.

Other novel features of our invention are hereinafter fully described and claimed.

In the accompanying drawings, we have illustrated different means for carrying our invention into effect.

Figure 1 is a diagrammatic view of a telephone system in which the primary circuit is divided into a plurality of pairs of branches, a pair of branches being located at each station, a condenser and a variable resistance device being located respectively in the two branches of each pair, two portions of the primary winding of an induction coil being located respectively in the two branches of each pair, the secondary winding of the induction coil being located in the secondary circuit which also includes the telephone receiver. Fig. 2 is a diagrammatic representation of a telephone system, similar to that shown in Fig. 1, with the exception that the induction coil is dispensed with, but two portions of the secondary circuit are subjected to opposite inductive action by the two branches of the primary circuit. Fig. 3 is a diagrammatic representation of a telephone system employing another modified form of our invention. In this form the apparatus is similar to that shown in Fig. 1. The variable resistance devices in the branches being dispensed with, one portion of the primary winding of the induction coil being inductively related to the secondary winding to a greater extend than the other portion of the primary winding. In Fig. 4, which represents a telephone system for carrying into effect another modified form of our invention, the two branches of the primary circuit at each station, contain respectively a condenser and a transmitter and are connected at their ends to the ground and to opposite ends of the primary winding of the induction coil, the line wire being connected centrally to the primary winding of the induction coil. Fig. 5 represents a telephone system similar to that shown in Fig. 1, the condensers and variable resistance devices not being employed. Fig. 6 represents two forms of apparatus for carrying into effect two modified forms of our invention. In this figure the primary windings of the two induction coils are located in series in the primary or transmitting circuit. In the form shown at station A, the two portions of the primary winding are oppositely wound, the secondary winding at that station being all wound in the same direction. In the form shown at station B, the two portions of the secondary winding are oppositely wound, the primary wire being all wound in the same direction. Fig. 7 represents a telephone system similar to that shown in Fig. 1, the condensers however, being replaced by resistance coils. Fig. 8 is a view similar to Fig. 1, with the exception that in Fig. 8 the resistance coils 9 and contacts 8 at stations A and B are omitted. Fig. 9 represents a central longitudinal sectional view of the induction coil shown in Figs. 1 and 4, and a diagrammatic representation of the other parts of the apparatus employed at a station.

Similar characters of reference denote similar parts.

Referring to Fig. 1, which illustrates one form of our invention, the primary circuit comprises a line conductor 1, which connects stations A and B, a battery 2, forming a portion of said conductor. The primary circuit at each station A and B, is divided into two branches united at opposite ends, the ground forming the return conductor. The apparatus at the two stations being identical, a description of one will suffice. 3 denotes the primary winding of an induction coil, the opposite ends of which are connected respectively to two conductors 4 and 5, the conductor 4 being connected to one pole of a condenser 6, the opposite pole of which connects to a conductor 7, which is connected to the conductor 1. The conductor 5 is connected to the movable contact 8, adapted to bear consecutively on the coils of a resistance coil 9, which has one end connected to a conductor 10, which in turn is connected to conductor 1. The contact 8 and coil 9 form an ordinary variable resistance device. 11 denotes an ordinary telephone transmitter located in and forming a part of a conductor 12, one end of which is connected to the ground, the other end being connected to the central whirl of the primary winding 3. 13 denotes the secondary winding of the induction coil, opposite ends of which are connected respectively to two conductors 14, which in turn are connected respectively to the opposite poles of an ordinary telephone receiver 15. One branch of each pair of branches comprises conductors 4 and 7, condenser 6, and one half of the primary winding 3. The other branch comprises the other half of the primary winding 3, conductors 5 and 10, and the variable resistance device 8—9. 16 denotes a foreign circuit adjacent to the primary circuit and from which are induced the disturbing currents which traverse the primary circuit. 17 denotes the core of the induction coil, preferably comprising a bundle of small iron wires, that portion lying within the portion of the primary winding which is located in the branch containing the condenser 6, containing preferably, for the reason hereinafter given, more iron than the portion of the core embraced by the other portion of the induction coil.

The following is a description of the operation of the system illustrated in Fig. 1:— The telephonic and disturbing currents passing along the conductor 1 will divide at stations A and B, the direct battery telephonic currents and a portion of the induced disturbing currents will pass by means of conductors 10 and 5 and variable resistance device 8—9, into and through one portion of the primary winding 3, and thence by conductor 12 and transmitter 11 to ground. The direct and alternating disturbing currents will also pass into the conductor 7 of the other branch, and by means of a condenser 6, will induce alternating currents in a conductor 4, which will pass through the other portion of the primary winding and thence through conductor 12 and transmitter 11, to ground. Both portions of the primary winding 3 being wound in the same direction, and the induced and direct currents from the branches passing in opposite directions through the two portions of the primary winding, will induce currents opposite in direction in the secondary winding 13. The currents induced in the branch containing the condenser 6 by the original disturbing currents will not have the same inductive effect upon the secondary winding 13 as will have the original disturbing currents which pass through the branch containing the conductor 10. The result would be therefore, that the original disturbing currents passing through that portion of the primary winding located in the branch containing the conductor 5, will, unless it is otherwise prevented, exert a preponderating inductive influence upon the secondary winding 13 and currents would flow in the secondary circuit which would cause disturbing noises in the telephone receiver 15. The inductive influence of the original disturbing currents and the inductive influence of the currents induced in the other branch thereby may be equalized or balanced in different ways. One way to balance or equalize the two fields of induction formed between the primary and secondary windings by the original and the induced disturbing currents is to reduce the inductive efficiency between that portion of the primary winding 3, located in the branch containing the conductor 5, and the secondary winding 13. This reduction in efficiency may be obtained by having the portion of the core 17, which is located in that portion of the primary winding, contain less iron than the other portion of the said core. Figs. 1 and 4 show such a core. Another way for balancing or equalizing the two inductive fields caused by the disturbing currents, is illustrated in Fig. 3. In this form the core throughout is of equal diameter, but a greater length of the primary winding is located in the branch containing the condenser 6, the conductor 12 being connected to the primary winding at one side of the central portion thereof. Another plan for equalizing or balancing the two opposite inductive fields is by the insertion of a proper amount of resistance in the branches containing the conductors 10, such resistances being the resistance devices 8—9, shown in Figs. 1 and 7. Another means for balancing the inductive fields is by movement of the core 17 lengthwise to the proper position. The two opposite fields of induction set up by the opposing original and induced disturbing currents being balanced or equalized, the currents induced in the secondary circuit will be in the contrary direction and of equal strength and will therefore nullify each other, so that none of the disturbing sounds will be heard in the telephone receiver located in the secondary circuit. The currents induced in the branch containing the condenser 6, by the direct telephonic currents traversing the primary, will have feeble effect in their inductive action upon the secondary winding 13 as compared with the powerful effect of the direct telephonic currents traversing the branch containing the conductor 5. The currents set up in the secondary circuit by the telephonic currents induced in the branch containing the condenser 6, will be comparatively weak and will not reduce to any appreciable extent the currents induced in the secondary circuit by the direct telephonic currents. The result will be that the telephonic sounds produced in the receiver will be very loud and distinct and disturbing sounds due to induction will be wholly eliminated.

In the form shown in Fig. 2 the apparatus employed is the same as in Fig. 1 with the exception that the induction coil is eliminated. Referring to said Fig. 2, 13′ denotes a portion of the secondary circuit comprising a conductor disposed parallel with a conductor 3′, said two conductors being inductively related to each other. The conductor 13 has its ends connected respectively to conductors 14, which are connected to the opposite poles of the telephone receiver 15, and constitute, with said receiver and conductor 13′ the secondary circuit. The conductor 3′ has its ends connected respectively to the conductors 4 and 5 which in turn are connected respectively to the condenser 6 and contact point 8. The conductors 7 and 10 are connected respectively to the condenser 6 and resistance coil 9 and also at their other ends to the conductor 1. The conductor 12, similar to that shown in Fig. 1, is connected midway between the ends of the conductor 13′ to the conductor 3′.

In the form shown in Fig. 2 the divided currents passing over the two branches of the primary circuit set up fields of induction of opposite character between the secondary conductor 13′ and the two portions of the conductor 3′, disposed upon opposite sides of the conductor 12. By adjusting the variable resistance 8—9 the two fields of induction formed by the disturbing currents may be equalized. The direct telephonic currents passing through the branch comprising the conductors 5 and 10, resistance device 8—9 and the portion of the conductor 3′ to the left of the conductor 12, will induce much stronger telephonic currents in the secondary circuit than are induced in said circuit by the induced telephonic currents traversing the opposite branch containing the condenser 6, and the talk heard in the telephone receiver will be loud and clear and free from disturbing sounds due to induction.

The form shown in Fig. 3 is similar to that shown in Fig. 1 with the exception that the variable resistance device is omitted and the conductor 10 connects directly with the conductor 5. The conductor 12, as stated hereinbefore, connects to the primary winding 3 at a point nearer one end than the other, so that the inductive fields set up by the original and the induced disturbing currents passing through the two branches respectively, will be balanced or equalized, as has been already described.

In the form shown in Fig. 4 the secondary circuit is identical with that shown in Fig. 3. In this form the conductor 5 connects with the central portion of the primary winding of the induction coil, one end of which is connected to the conductor 12, which contains the transmitter 11 and is connected with the ground. The other end of the primary winding is connected to the conductor 17′, which is connected to one pole of a condenser 6, the other pole of which is connected to a conductor 18, which is connected with the ground.

In the form of the invention shown in Fig. 4, the direct telephonic and the alternating disturbing currents pass from the conductor 1 over the conductors 10 and 5, dividing at the center of the primary winding of the induction coil, the direct telephonic current passing through that portion of the primary winding connected to the conductor 12, thence by said conductor 12 to the ground. The disturbing currents and the direct telephonic currents fill that portion of the primary winding connected with the conductor 17′, causing alternating currents to be induced by means of the condenser 6 and the conductor 18. As described with reference to the preceding forms, two opposite fields of induction are formed between the primary and secondary windings which generate opposing currents in the secondary circuit. To balance the inductive fields produced by the disturbing currents, a core 17, similar to that shown in Fig. 1, is provided in the induction coil, the smaller portion being located in that portion of the primary winding through which the direct telephonic currents pass.

The form shown in Fig. 5 is similar in construction to that shown in Fig. 3, with the exception that the condenser 6 is omitted and the conductor 12 connects centrally with the primary winding of the induction coil. The condenser being omitted and the inductive fields being similar and equally balanced, the telephonic and disturbing currents would pass equally through both branches of the primary circuit and the currents set up in the secondary winding would be equal and contrary in direction, and no sounds would be heard in the receiver 15. By lengthwise moving the primary winding 3 and core 17 relative to the secondary winding 13, the two fields of induction may be so unbalanced that the telephonic currents passing through one branch will have more effect on the secondary circuit than will those passing through the other branch. We have found by actual test that such adjustment may be made so that very good clear talk may be heard in the receiver before any disturbing sounds due to induction will manifest themselves. The field may be similarly unbalanced by withdrawing the core 17 from the primary winding. The distance said core is withdrawn being determined by trial. That is, it may be withdrawn until the disturbing sounds are faintly heard, at which time the telephonic sounds will be quite loud and very clear.

In Fig. 6 an apparatus is shown which illustrates two modifications. The secondary circuit at station A corresponds to the secondary circuit shown in Fig. 1. The primary winding 3ª of the induction coil at station A comprises two equal portions wound around the core 17 in opposite directions, said primary winding preferably extending at its ends beyond the ends of the secondary winding 13. The line conductor 1 has its ends connecting respectively to one set of ends of the primary windings 3 and 3ª, the other ends of said primary windings being connected respectively to the two conductors 12, which extend to the ground and include the transmitters 11. The secondary winding 13ª at station B, has two portions oppositely wound, the ends of the secondary winding preferably extending beyond the ends of the primary winding 3 which encircles a core 17. The two cores 17 are each of equal diameter throughout. The telephonic and disturbing alternating currents passing over the conductor 1, will pass through the primary windings 3 and 3ª. If the two portions of the primary winding 3ª have exactly the same number of convolutions exposed to the same number of convolutions in the secondary winding 13, and are otherwise related in exactly the same way to the secondary winding, the two opposite fields of induction set up by the currents passing through the oppositely wound portions of the primary winding 3ª, will be of the same strength and the currents produced in the secondary circuit at station A would neutralize each other. By moving either of the two windings, 3ª, or 13, lengthwise relative to the other winding, the two fields of induction may be changed so that one will preponderate over the other. The telephonic currents induced in the secondary winding 13 being the stronger will be the first to cause sound to be heard in the receiver 15, at station A. The more the fields of induction at station A are relatively changed the louder the telephonic sounds that will be heard in the receiver at that station. This adjustment may be continued until the fields of induction are so unbalanced that the disturbing sounds caused by induction may be faintly heard in the receiver. It will be found that before this occurs the telephonic sounds will be quite loud and very distinct. At station B the currents passing through the primary winding 3 will, owing to the secondary winding being oppositely wound in its two portions, induce currents of equal strength and contrary in direction in the secondary circuit at station B. The two fields of induction at station B may be unbalanced to a degree that a telephonic sound but not the disturbing sounds will be heard in the receiver 15 at station B. This unbalancing of the two fields of induction may be obtained as described with reference to the apparatus at station A, by a movement lengthwise of one of the two windings of the induction coil relative to the other. The two fields of induction at either station A or station B may also be unbalanced to the proper degree by lengthwise movement in the primary windings of the cores 17.

Fig. 7 represents a modified form of telephone system similar to that shown in Fig. 5 excepting that each branch at each station contains a resistance device. The conductor 7 is connected to one end of a resistance coil, the other end of which connects to the conductor 4 which also connects with one end of the primary winding 3. In the opposite branch the conductor 10 connects with the movable contact 8 which bears upon the resistance coil 9, said resistance coil connecting at one end to the conductor 5 which connects with the other end of the primary winding 3. The conductors 12 at each station connect to the central portion of the primary winding and also with the ground.

In the form shown in Fig. 7 the telephonic and disturbing currents divide and pass at each station through the two branches containing the resistance 18 and 8—9. By properly moving the contact 8 the opposite magnetic fields established between the two portions of the primary winding 3 and the secondary winding 13, may be unbalanced to a degree in which telephonic but not the disturbing sounds will be produced in the receivers 15. Adjustment of the contact 8 to a position in which either more or less resistance will be in one branch than in the other branch will effect this result. The proper position for the contact 8 may be determined by experiment.

In Fig. 8 is illustrated the preferred apparatus for carrying into effect the preferred form of our invention. This form of apparatus is similar to that shown in Fig. 1 with the exception that the variable resistances 8—9 are dispensed with, the conductors 10, which are connected to the conductor 1, being connected to the conductors 5 respectively, which in turn are connected respectively to one set of ends of the primary windings 3 of two induction coils, located respectively at stations A and B. Two conductors 12, including therein respectively the transmitters 11, connect at one set of ends at the two stations A and B, to the ground, the other set of ends being connected respectively to the central portions of the primary windings 3 respectively. Two cores 17 are inserted in the primary windings 3 respectively, that portion of each core located in that portion of the primary winding 3 which is located in the branch containing the conductors 5 and 10, having less diameter than the other portion of the core. The conductors 7, which connect at stations A and B respectively with the conductor 1, are connected respectively to like poles of the two condensers 6, the opposite poles of which are connected respectively to the conductors 4, which in turn connect respectively with the ends of the primary windings 3, opposite those to which are connected the conductors 5. The conductor 1 includes a battery 2. The ends of the secondary winding 13 are connected respectively to conductors 14 which connect with the two binding posts of the telephone receiver 15.

In the preferred form of apparatus shown in Fig. 8, the direct telephonic and the alternating disturbing currents pass through conductor 1, thence through conductors 10 and 5, thence through one portion of the primary winding 3 to conductor 12, and thence to ground. The said direct and alternating currents passing over conductor 7 induce currents by means of the condenser 6. Said currents being alternating in form, pass through conductor 4, thence through the adjacent portion of the primary winding 3, to the conductor 12, and thence to ground. As hereinbefore stated, the direct telephonic currents and the original disturbing currents which pass through the branch containing the conductors 5, have greater inductive effect upon the secondary winding 13 than the currents induced by means of the condenser 6. In order that the two opposite fields of induction, which are produced by the original disturbing currents passing through one branch and by the induced alternating disturbing currents passing through the opposite branch, may be balanced, the inductive efficiency between the secondary winding 13 and that portion of the primary winding through which passes the direct telephonic currents must be less than the inductive efficiency between the other portion of the primary winding and the secondary winding. As illustrated in Fig. 8, this may be obtained by providing a core having a larger amount of iron in that portion of the primary winding connected with the condenser 6 by the conductor 4. Or the fields of induction may be unbalanced to the proper degree by longitudinal movement of the core 17 in the primary winding or by longitudinal movement of one of the windings of the induction coil relative to the other.

In Fig. 9 is illustrated in central longitudinal section an induction coil of the type employed in the forms shown in Figs. 1, 4, and 8. In this figure is illustrated a spool 19, which contains a series of layers of wire which forms the secondary winding 13. One end of the winding 13 is connected to one of the conductors 14, which at its opposite end is secured to one of the binding posts of the telephone receiver 15. The other end of the winding 13 is connected by a conductor 14 to the opposite binding post. Located in the axial hole in the spool 19 is a spool 20, on the periphery of which are wound two coils of wire which form the primary winding 3. The two coils of wire are in one or more layers and are of equal length. These two coils of wire are wound in the same direction and have their inside ends connected to each other by a conductor 21. The opposite ends of the two coils are connected respectively to the two conductors 4 and 5, which connect respectively to one pole of the condenser 6 and to the conductor 10. The core 17 comprises preferably a plurality of small wires located within the central opening of the spool 20. That portion of the core which is embraced by the coil of wire connected to the conductor 4, preferably contains a greater number of soft iron wires than is contained in that portion embraced by the coil which connects with the conductor 5.

While the drawings illustrate the ground as forming a part of the primary circuit, it will be obvious that a metallic conductor may be employed for the return portion of the circuit. In employing the ground for the return portion of the circuit results equally as good as with a metallic return are obtained, so that by dispensing with the return metallic return much expense of construction may be obviated. In the employment of a ground connection for the line conductor those static discharges which frequently occur in metallic circuits are obviated.

Many modifications other than those shown and described may be made within the scope of the appended claims without departing from the spirit of our invention.

Having thus described our invention, what we claim and desire to secure by Letters Patent is:—

1. In a telephone system, the method consisting in transmitting direct telephonic currents in a primary circuit between two stations, dividing said direct currents and such disturbing currents as traverse the said primary circuit, and subjecting two portions respectively of a local secondary circuit to opposite and unequal inductive action by said divided currents.

2. In a telephone system, the method consisting in transmitting direct telephonic currents in a primary circuit between two stations, dividing said direct currents and such disturbing currents as traverse the primary circuit, and subjecting two portions respectively of each of a plurality of local secondary circuits to opposite and unequal inductive action by said divided currents.

3. In a telephone system, the method consisting in transmitting direct telephonic currents between two stations connected by a primary circuit, and subjecting two portions respectively of a local secondary circuit to opposite and unequal inductive action of said direct telephonic currents, and disturbing currents traversing the primary circuit.

4. In a telephone system, the method consisting in transmitting direct telephonic currents between two stations connected by a primary circuit, and subjecting two portions respectively of each of a plurality of local secondary circuits to opposite and unequal inductive action by said direct telephonic currents and the disturbing currents traversing the primary circuit.

5. In a telephone system, the method consisting in subjecting two portions respectively of a secondary circuit to opposite and unequal inductive action by currents traversing a primary circuit.

6. In a telephone system, the method consisting in subjecting two portions respectively of each of a plurality of secondary circuits to opposite and unequal inductive action by currents traversing a primary circuit.

7. In a telephone system, the method consisting in subjecting two portions respectively of a secondary circuit to opposite inductive action by currents traversing a primary circuit, the two inductive fields thus formed differing in strength.

8. In a telephone system, the method consisting in subjecting two portions respectively of each of a plurality of secondary circuits to opposite inductive action by a current traversing a primary circuit, the inductive efficiency between the said two portions of each secondary circuit and of the primary circuit differing in degree.

9. In a telephone system, the method consisting in employing the telephonic and other currents traversing a primary circuit to induce alternating currents in said primary circuit, and subjecting two portions respectively of a secondary circuit to opposite inductive action of the original and induced currents traversing the primary circuit.

10. In a telephone system, the method consisting in employing the telephonic and other currents traversing a primary circuit to induce alternating currents in said primary circuit, and subjecting two portions respectively of each of a plurality of secondary

circuits to opposite inductive action of the original and induced currents traversing the primary circuit.

11. In a telephone system, the method consisting in employing telephonic and other currents traversing a primary circuit to induce alternating currents in said circuit, and subjecting two portions respectively of a secondary circuit to opposite inductive action of the original and induced currents traversing the primary circuit, the two fields of induction thus formed between said two portions and the primary circuit differing in strength.

In testimony whereof we have signed our names to this specification in presence of two subscribing witnesses.

WILLIAM CONDON.
ALBERT BARRETT.

Witnesses:
WARREN D. HOUSE,
E. B. HOUSE.