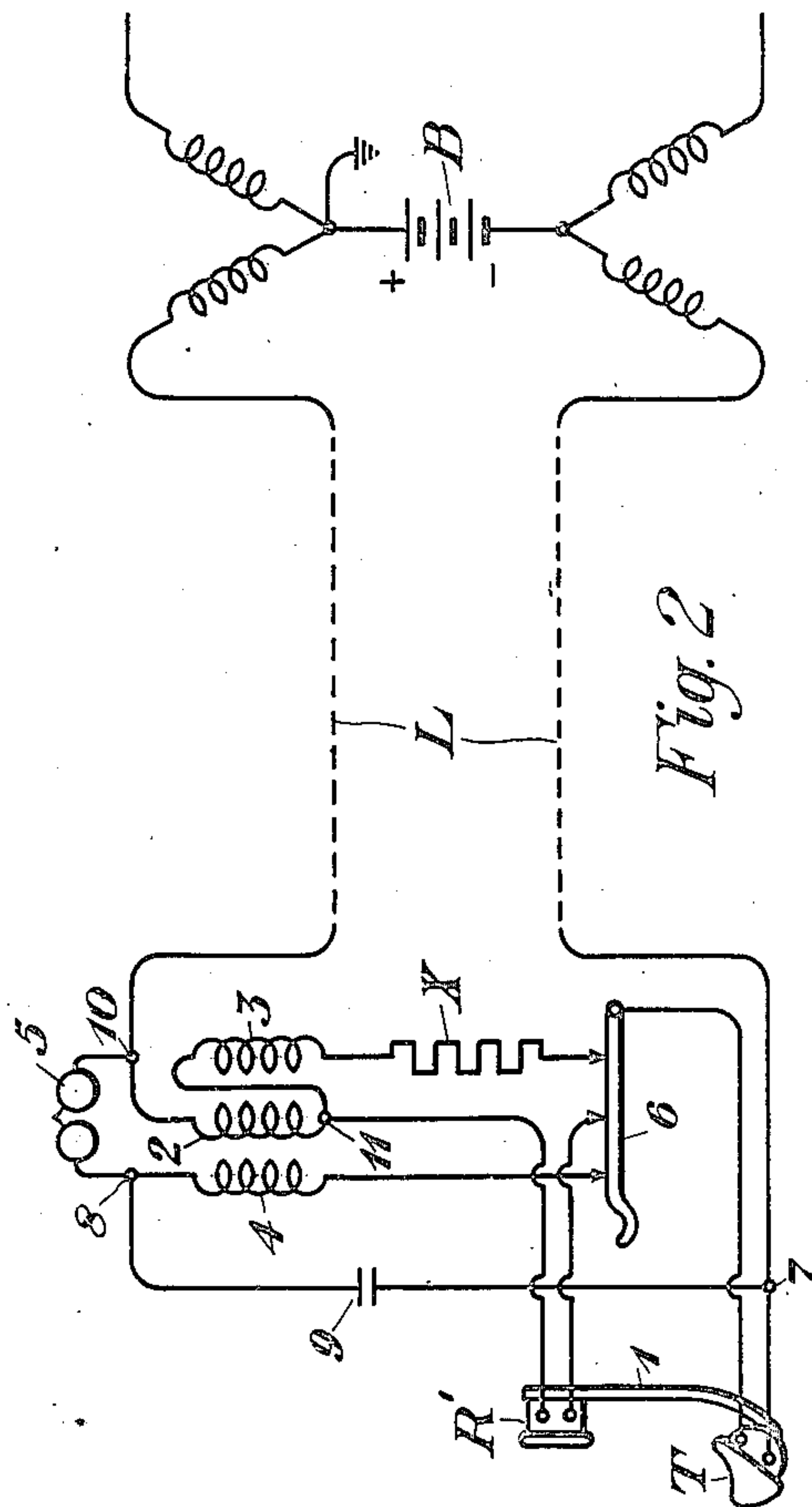
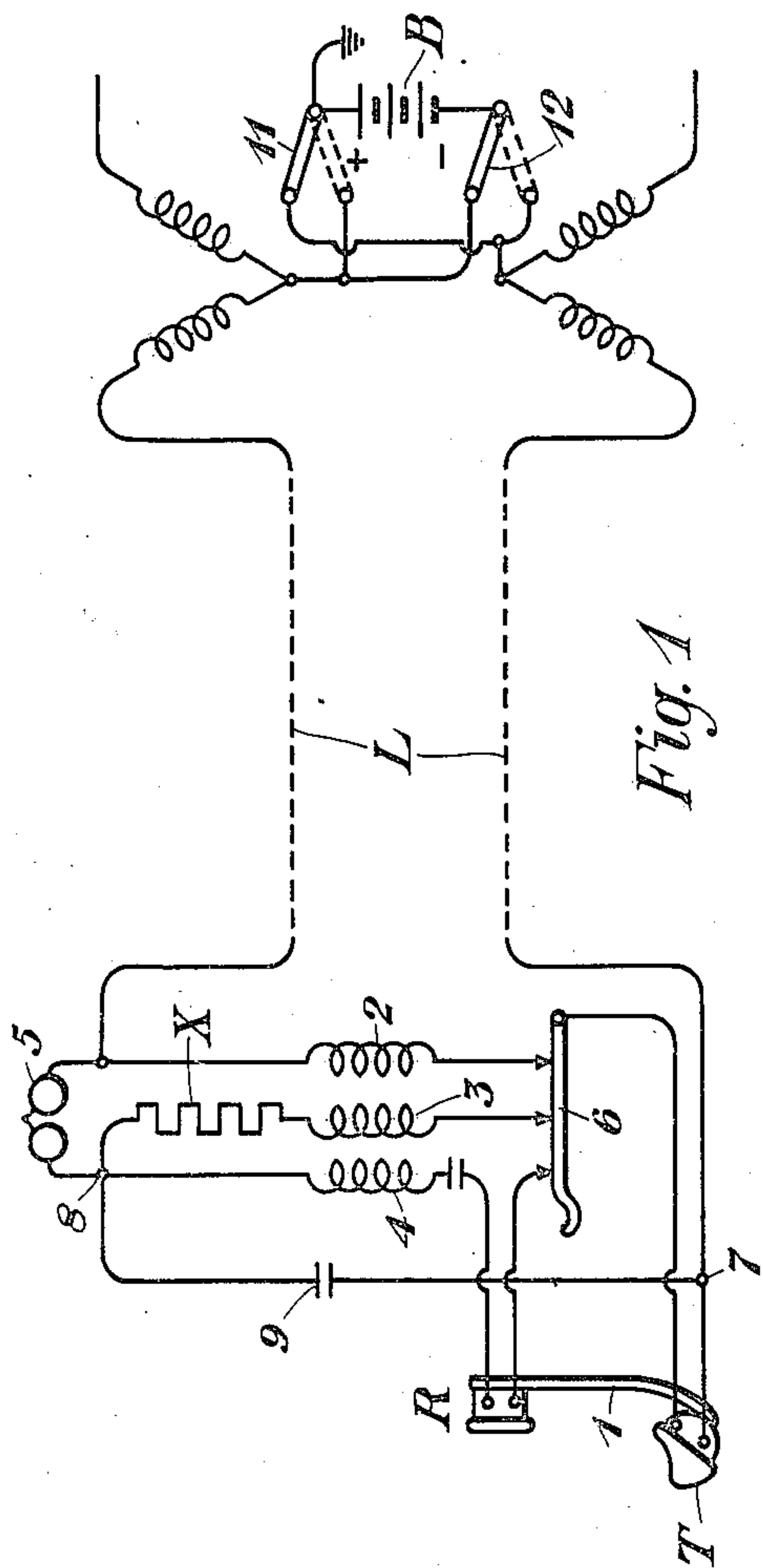
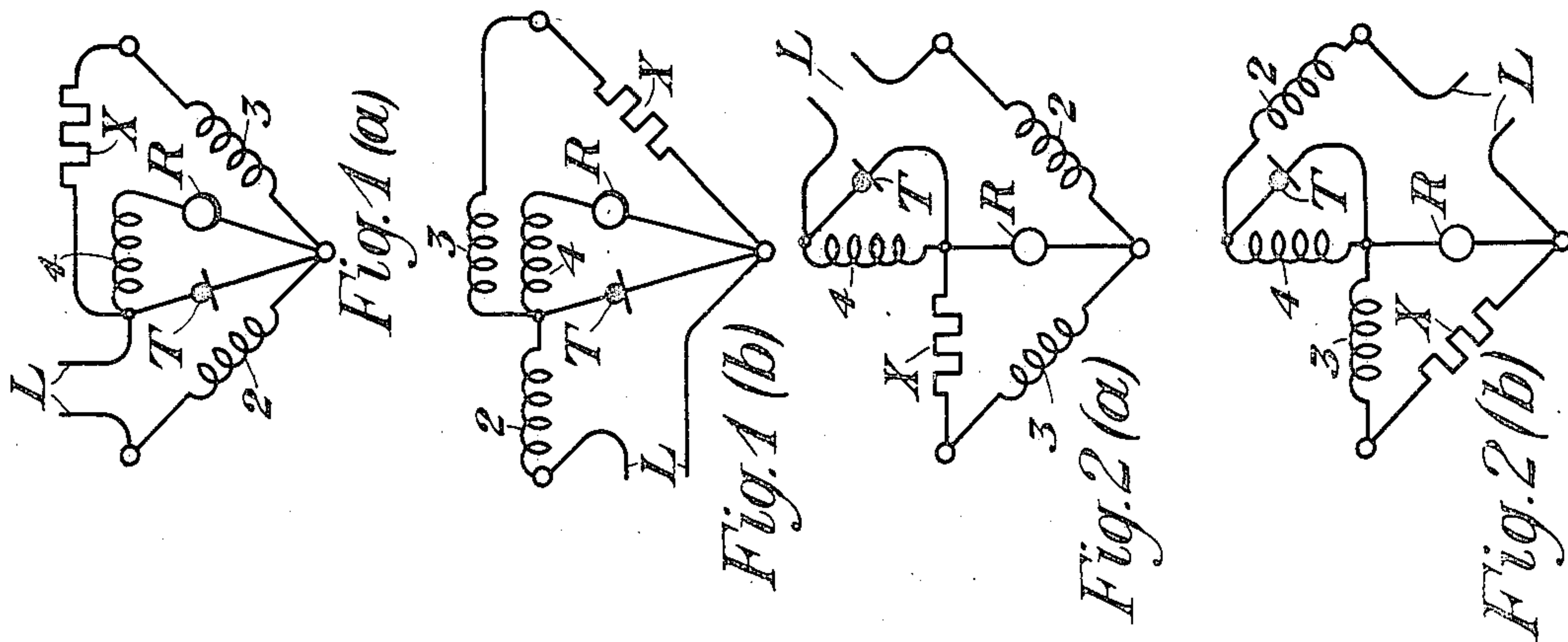


G. K. THOMPSON.
 ANTISIDE TONE HAND SET.
 APPLICATION FILED JUNE 28, 1918.

1,402,322.

Patented Jan. 3, 1922.



INVENTOR.
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UNITED STATES PATENT OFFICE.

GEORGE K. THOMPSON, OF MAPLEWOOD, NEW JERSEY, ASSIGNOR TO AMERICAN
TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

ANTI-SIDE-TONE HAND SET.

1,402,322.

Specification of Letters Patent.

Patented Jan. 3, 1922.

Application filed June 28, 1918. Serial No. 242,414.

To all whom it may concern:

Be it known that I, GEORGE K. THOMPSON, residing at Maplewood, in the county of Essex and State of New Jersey, have invented certain Improvements in Anti-Side-Tone Hand Sets, of which the following is a specification.

This invention relates to telephone circuits, and more particularly to telephone circuits in which the substation equipment includes a so-called hand-set, i. e., a set in which the transmitter and receiver are both mounted on a common frame or handle so as to form a unitary structure.

Difficulty has been experienced in the use of sets of this type heretofore, in that where sensitive transmitters and receivers such as are necessary to conform to standard telephone practice were used, singing took place on relatively short subscribers' loops. This singing was due to the fact that the two instruments were connected together by a rigid connection through which vibrations might readily pass from one to the other. In some cases, if the instrument was held so that the transmitter was in its most microphonic position, the hand-set would start to sing of itself, the transmitter receiving its first impulse from some local sound, which, once reproduced by the receiver, reacted upon the transmitter again and thus caused a constant sound to be emitted by the receiver.

Another difficulty arose even where the instruments were not sufficiently sensitive to sing, viz., there might be sufficient interaction between the receiver and transmitter, due to the vibration transmitted between the instruments, to affect the articulation.

Numerous attempts have heretofore been made to overcome the difficulties above referred to, both by changes in the mechanical construction and in the circuit connections, but such attempts have been without completely satisfactory results. While the difficulty might by such changes be partly overcome, so that in a given set no difficulty would arise from singing, another set of instruments would be subject to this defect. This was probably due to uncontrollable variations in the natural periods of the dia-

phragms of the instruments. That is, if the diaphragms of both instruments happen to have their maximum response at the same frequency, they become extremely sensitive to singing as compared with two instruments having diaphragms which respond to different frequencies.

It is therefore necessary to devise some arrangement which will practically eliminate the tendency to sing in apparatus of this character, and one of the principal objects of this invention is to secure such an arrangement, although other and further objects of the invention will be apparent from the detailed description hereinafter given. These objects may be secured in accordance with the present invention by associating with the hand-set an anti-side tone substation circuit of the type in which four fundamental impedance elements consisting of the transmitter, receiver, balancing impedance and line are employed, said elements being so associated with the windings of a transformer as to render the first two elements above mentioned conjugate with respect to each other during transmission, and the last two elements conjugate during reception. In other words the arrangement is such that an electromotive force generated by the transmitter during transmission will cause no current flow in the receiver, and an electromotive force applied to the line during reception will cause no current flow in the balancing impedance.

The general theory and design of substation circuits of this type are fully set forth in a number of patents issued to George A. Campbell, under date of January 22, 1918. While for purposes of illustration, circuits of the general type disclosed in Campbell Patent No. 1,254,471 of January 22, 1918 and in Johnson application Serial Number 210265 filed January 4, 1918 are employed, it will be understood that any substation circuit involving the principles of the so-called Campbell substation may be used, as for example, the substations disclosed in Campbell Patents Nos. 1254116, 1254117, 1254118, 1254472, 1254473, 1254474, 1254475, 1254476 and Martin Patent No. 1254146, all issued January 22, 1918.

By the use of a circuit arrangement of the character above described, it has been found that the tendency to sing may be eliminated under practically all service conditions, though under certain conditions some tendency to sing persists even when the anti-side tone circuit is employed. It has been found, however, that this tendency can be eliminated in all cases where a permanent magnet receiver is used by reversing the current supply connections or by reversing the normal receiver connections.

The invention may now be more fully understood from the following detailed description when read in connection with the accompanying drawing, Figures 1 and 2 of which are diagrams showing two possible embodiments of the invention, while Figures 1^a, 1^b and Figures 2^a and 2^b are schematic diagrams showing the relation of the circuits of Figures 1 and 2 to certain types of Campbell anti-side tone substations.

Referring to Figure 1, a hand-set is shown comprising a transmitter T and a permanent magnet receiver R, mounted upon a common handle or frame member 1 so as to form a unitary structure. The substation circuit also includes an auxiliary resistance X and a transformer comprising windings 2, 3 and 4. The resistance X serves as a balancing element for the line L with which the substation is associated and while for purposes of illustration the resistance is indicated as being a separate element, it will be understood that the winding 3 may be made of sufficiently high resistance to accomplish the desired result without necessitating a separate resistance element. The usual ringer 5 and switch hook 6 are also provided, the latter being so arranged as to separately break the circuits including the three transformer windings.

The four fundamental elements, namely, the transmitter, receiver, auxiliary resistance and line are connected in four parallel circuits. The circuit including the transmitter T extends from the switch hook to terminal 7. The receiver circuit includes winding 4 and extends from the switch hook 6 to terminal 8, which is strapped to terminal 7 through a condenser 9. The auxiliary resistance or balancing circuit includes resistance X and winding 3, and extends from the switch hook to terminal 8. The line circuit includes winding 2 and extends from the switch hook 6 through said winding and over the line L to terminal 7. This arrangement is indicated schematically in Figure 1^a, which clearly shows the parallel arrangement of the four circuits. It is apparent that the relative arrangement of the elements in any one of the series circuits may be reversed without in any way affecting the operation of the circuit. In Figure 1^b the relative arrangement of the line L and wind-

ing 2 is reversed as well as the arrangement of the auxiliary resistance X and winding 3. A comparison of this diagram with those shown in patent to Campbell, No. 1254471, already referred to, shows that this circuit is identical with the circuit of Figure 13 of said patent, and consequently the substation circuit arrangement employed in Figure 1 corresponds to this type of Campbell circuit.

As fully set forth in the above mentioned Campbell patent, by properly proportioning the elements and relating them to each other, such a substation will be anti-side tone, that is, the transmitter and receiver will be conjugate during transmission. Furthermore, the line and auxiliary resistance will be conjugate during reception, and the impedance of the substation as viewed from the line will be equal to that of the line, while the impedance of the combination connected across the terminals of the transmitter will be equal to that of the transmitter. By employing a substation arrangement having the above mentioned characteristics, reaction between the transmitter and receiver may be substantially eliminated, at the same time maintaining the over-all efficiency of a system involving two such substation circuits interconnected by a line at a maximum.

Tests have been made of a circuit of this type used in connection with the hand-set under practically all service conditions, and these tests indicate that under substantially all of these conditions the tendency to sing, which is inherent in a hand-set involving a sensitive transmitter and receiver, will be eliminated or very materially reduced, and doubtless by careful design of the elements of a circuit of this type this tendency might be entirely eliminated under all conditions. It has been found, however, that by employing a simple expedient in addition to the use of an anti-side tone circuit of this type, the tendency to sing may be eliminated under all practical conditions, even with the approximately designed substation sets now available. As is well known, the standard practice is to connect the negative terminal of the central office battery B to that side of the line L which is connected directly to the transmitter at terminal 7. This arrangement is indicated by the dotted line position of the switch 11 and 12. By reversing the battery connections as indicated by the full line position of the switch 11 and 12 so that the positive terminal of the battery is connected to terminal 7 of the substation, it has been found that the tendency to sing, which is due to the inaccuracies in the design and manufacture of the substation apparatus, may be entirely eliminated. The same result may be, of course, secured by reversing the line connections instead of the

battery connections. It has also been found that simply reversing the receiver connections would bring about the same result. This phenomenon is doubtless due to the fact that any one of the above changes in the connections produces changes in the time intervals between the motion of the receiver diaphragm and the energizing impulses tending to actuate the diaphragm—which impulses pass through the receiver winding and are produced by variations in the transmitter circuit, repeated by the transformer into the receiver circuit—so that the condition of consonance between the movements of the diaphragm and the forces tending to keep it in motion is disturbed, and a condition of dissonance is set up resulting in interference between the movements of the diaphragm and energizing impulses, which prevents a continuation of singing.

While the results above referred to were secured by means of tests in which a circuit of the type shown in Figure 1 was employed, it is obvious that similar results might be secured by using any of the so-called Campbell substation circuits. For instance, a Campbell circuit of a different type adapted to use an electromagnetic receiver is shown in Figure 2. The circuit of this figure differs from that of Figure 1 in that the receiver R', is connected in circuit with winding 2 instead of winding 4, and the circuit including the resistance X and the winding 3 is not connected to the terminal 8 but is connected to the junction point between the winding 2 and the receiver R'. The receiver R' is of the electromagnetic type so that its magnet is energized by direct current from the battery B instead of by a permanent magnet. In order to provide a direct path for the receiver it is connected in series with the line L through the winding 2. The circuit is in its general characteristics similar to that of Fig. 1 and functions in a similar manner with regard to the hand set. A schematic diagram of the circuit is shown in Figure 2^a. Here, again, it is obvious that the relative arrangement of the line L and induction coil 2, as well as the auxiliary resistance X and induction coil 3, may be reversed as shown in Figure 2^b. A comparison of the circuit of Figure 2^b with the circuits of Campbell patent No. 1254116, previously referred to, shows that this circuit is similar to that of Figure 1 of said patent, differing therefrom only in the arrangement of the transformer windings. This particular modification of the general type of Campbell substation is disclosed and claimed in Johnson application Serial Number 210265 filed Jan. 4, 1916.

By means of the arrangements above described it thus becomes possible to use a hand-set without encountering the difficulties heretofore experienced from singing. It

will also be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims:

What is claimed is:

1. In combination with a telephone line, a substation, said substation comprising a transmitter and receiver mounted upon a common frame or handle to form a unitary structure such that disturbances in the receiver may be transmitted to the transmitter by the mechanical connection, an electrical circuit to complete a singing path from the transmitter to the receiver, said electrical circuit including a balancing resistance and a transformer, said transmitter, receiver, balancing resistance and transformer being so proportioned with respect to each other and the line and being so connected that the transmitter and receiver will be conjugate and the electrical transmission from the transmitter to the receiver of impulses mechanically transmitted from the receiver to the transmitter will be defeated.

2. In combination with a telephone line, a substation, said substation comprising a transmitter and receiver mounted on a common frame to form a unitary structure such that impulses from the receiver may be transmitted to the transmitter through the mechanical connection, an electrical circuit to complete a singing path from said transmitter to said receiver, said electrical circuit including a balancing resistance and a transformer, said transmitter, receiver, balancing resistance and transformer being so proportioned with respect to each other and the line, and being so connected that the transmitter and receiver are conjugate, the line and balancing resistance are conjugate, and the electrical transmission from the transmitter to the receiver of impulses mechanically transmitted from the receiver to the transmitter will be defeated.

3. In a two-way signaling system, a circuit for the transmission and reception of signals, a transmitting circuit proper including a transmitter, a receiving circuit proper including a receiver, said transmitter and receiver being mounted on a common frame to form a unitary structure such that impulses may be transmitted from the receiver to the transmitter through the mechanical connection, an electrical circuit to complete a singing path from the transmitter to the receiver, said electrical circuit including a balancing circuit and a transformer with a plurality of windings, said circuit for the transmission and reception of signals, said transmitting circuit proper, said receiving circuit proper, said balancing circuit and said transformer being so proportioned and related that said receiving circuit and trans-

mitting circuit proper are conjugate, and the electrical transmission from the transmitter to the receiver of electrical impulses mechanically transmitted from the receiver to the transmitter will be defeated.

4. In a two-way signaling system, a circuit for the transmission and reception of signals, a transmitting circuit proper including a transmitter, a receiving circuit proper including a receiver, said transmitter and receiver being mounted on a common frame to form a unitary structure such that impulses may be transmitted from the receiver to the transmitter through the mechanical connection, an electrical circuit to complete a singing path from the transmitter to the receiver, said electrical circuit including a balancing circuit and a transformer with a plurality of windings, said circuit for the transmission and reception of signals, said transmitting circuit proper, said receiving circuit proper, said balancing circuit and said transformer being so proportioned and related that the transmitter and receiver are conjugate, said balancing circuit and said first named circuit are conjugate, and the electrical transmission from the transmitter to the receiver of electrical impulses mechanically transmitted from the receiver to the transmitter will be defeated.

5. In a telephone system including a line circuit, a transmitting circuit including a transmitter, a receiving circuit including a receiver, said transmitter and receiver being mounted on a common frame to form a unitary structure such that impulses may be transmitted from the receiver to the transmitter through the mechanical connection, a balancing circuit and a transformer having windings in certain of said circuits, said circuits having a common terminal and central station source of supply current having its negative terminal connected to said common terminal through said line circuit only, and said transmitting circuit, receiving circuit, balancing circuit and transformer being so proportioned with respect to each other and the line and being so connected that said transmitter and receiver will be conjugate and the electrical transmission from said transmitter to said receiver of impulses mechanically transmitted from the receiver to the transmitter will be defeated.

6. In a telephone system including a line circuit, a transmitting circuit including a transmitter, a receiving circuit including a receiver, said transmitter and receiver being mounted on a common frame to form a unitary structure, a balancing circuit, a transformer having windings in certain of said circuits, said circuits having a common terminal, and a central station source of supply current having its negative terminal connected to said common terminal through said line circuit only, the elements of said

system being so proportioned and connected that said transmitting circuit and said receiving circuit are conjugate.

7. In a telephone system including a line circuit, a transmitting circuit including a transmitter, a receiving circuit including a receiver, said transmitter and receiver being mounted on a common frame to form a unitary structure, a balancing circuit, a transformer having windings in certain of said circuits, said circuits having a common terminal, and a central station source of supply current having its negative terminal connected to said common terminal through said line circuit only, the elements of said system being so proportioned and connected that said balancing circuit and line circuit are conjugate.

8. In combination with a telephone line, a substation, said substation comprising a transmitter and a receiver mounted on a common frame to form a unitary structure such that impulses may be transmitted from the receiver to the transmitter through the mechanical connection, an electrical circuit to complete a singing path from the transmitter to the receiver, said electrical circuit including a balancing resistance and transformer, said transmitter, receiver, balancing resistance and transformer being so proportioned with respect to each other and the line and being so connected that the transmitter and receiver are conjugate and a condition of dissonance is set up between the receiver diaphragm and the forces electrically transmitted through said electrical circuit, tending to keep said diaphragm in motion.

9. In combination with a telephone line, a substation, said substation comprising a transmitter and receiver mounted upon a common frame or handle to form a unitary structure such that disturbances in the receiver may be transmitted to the transmitter by the mechanical connection, an electrical circuit to complete a singing path from the transmitter to the receiver, a balancing circuit including resistance, said transmitter, receiver and balancing resistance being so proportioned with respect to each other and the line and being so connected that the transmitter and receiver will be conjugate and the electrical transmission from the transmitter to the receiver of impulses mechanically transmitted from the receiver to the transmitter will be defeated.

10. In a two-way signaling system, a circuit for the transmission and reception of signals, a transmitting circuit proper including a transmitter, a receiving circuit proper including a receiver, said transmitter and receiver being mounted on a common frame to form a unitary structure such that impulses may be transmitted from the receiver to the transmitter through the mechanical

connection, an electrical circuit to complete a singing path from the transmitter to the receiver, a balancing circuit, said circuit for the transmission and reception of signals, 5 said transmitting circuit proper, said receiving circuit proper and said balancing circuit being so proportioned and related that the receiving circuit and transmitting circuit proper are conjugate and the elec-

trical transmission from the transmitter to 10 the receiver of electrical impulses mechanically transmitted from the receiver to the transmitter will be defeated.

In testimony whereof, I have signed my name to this specification this 17th day of 15 June, 1918.

GEORGE K. THOMPSON.