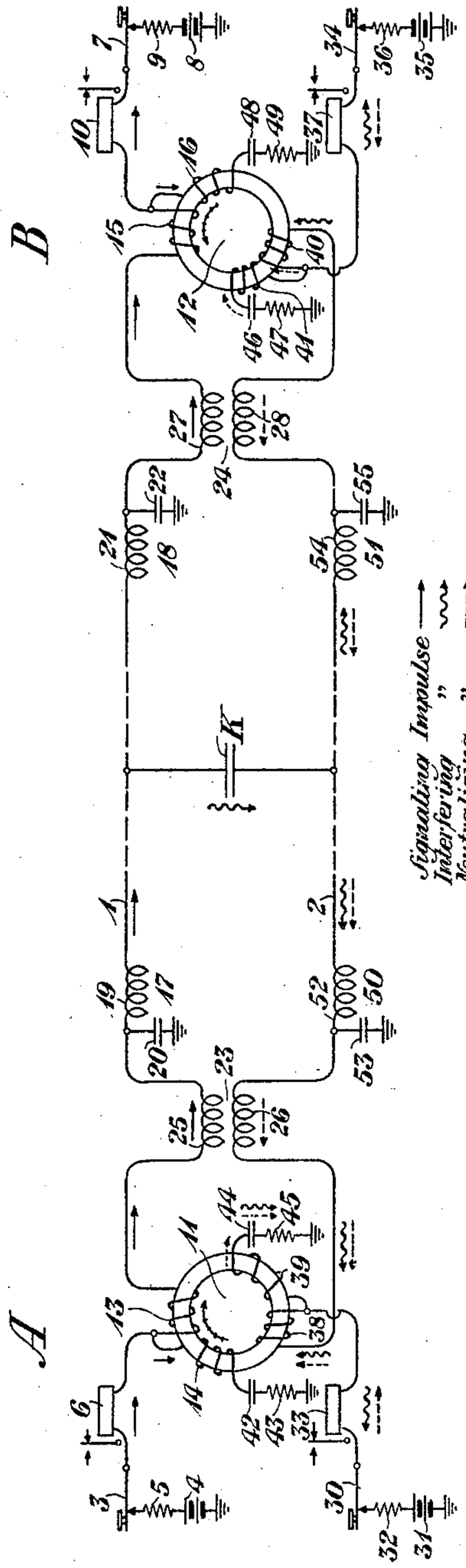
April 28, 1925. 1,535,104

S. I. CORY

MEANS FOR PREVENTING ELECTRICAL INTERFERENCE

Filed May 6, 1922



INVENTOR.

BY S. I. Cory

ATTORNEY

Patented Apr. 28, 1925. 1,535,104

UNITED STATES PATENT OFFICE.

SAMUEL I. CORY, OF ELMHURST, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

MEANS FOR PREVENTING ELECTRICAL INTERFERENCE.

Application filed May 6, 1922. Serial No. 559,010.

To all whom it may concern:

Be it known that I, SAMUEL I. CORY, residing at Elmhurst, in the county of Queens and State of New York, have invented certain Improvements in Means for Preventing Electrical Interference, of which the following is a specification.

This invention relates broadly to means for protecting circuits from external interference, and more particularly to an arrangement for reducing or preventing cross-fire in a system of grounded telegraph circuits.

In the operation of grounded telegraph circuits in which signals are transmitted by means of impulses of opposite polarity, interfering impulses are set up in adjacent circuits to that over which the signals are being transmitted by virtue of the mutual admittance between the various circuits of the system. These interfering impulses, which are created in the exposed circuits, flow to ground at each end of the exposed circuits in proportion to the magnitude of the impedances. The effect of the interfering impulses that flow through the distant receiving apparatus of the exposed circuits is termed the receiving-end cross-fire, and the effect that the interfering current produces in the receiving apparatus in the exposed circuits at the near, or home, end of the exposed circuits, is known as sending-end cross-fire.

In my copending application, Serial No. 533,370, filed February 1, 1922, I have shown an arrangement whereby, in a duplex telegraph system, the receiving-end cross-fire in the exposed circuits is prevented or greatly reduced by an inductive coupling between the disturbing and the disturbed circuits. In the system therein disclosed, the transmission of a signaling impulse over one circuit will produce in the disturbed circuit not only an interfering impulse but also a neutralizing impulse, which is adapted to oppose and neutralize the interfering impulse that would tend to pass through the distant receiving apparatus and cause a disturbance therein. In such system, the sending-end cross-fire is prevented by means of condensers connected between the artificial lines of the disturbing and disturbed circuits so that by means of this combination of devices, both the receiving-end and sending-end cross-fire is prevented. An inductive coupling of the type shown in the said copending application would tend to neutralize the receiving-end cross-fire in single-line Morse circuits, but, at the same time it would tend to increase the sending-end cross-fire in such circuits.

It is the object of this invention to provide an inductive arrangement for neutralizing both the receiving-end and the sending-end cross-fire in single-line Morse circuits.

This invention will be better understood from the following description when read in connection with the attached drawing, which shows one form of embodiment of the invention.

In the drawing, 1 and 2 represent two line circuits of a telegraph system having terminal circuits connected thereto. Thus, at station A the terminal circuit connected with line 1 contains a key 3, a grounded source of potential 4, a current-limiting resistance 5 and a line relay 6, and at station B the terminal circuit connected with the line 1 contains a key 7, a grounded source of potential 8, (which is of opposite polarity to the source 4) a current-limiting resistance 9 and a line relay 10. The terminal circuit of line 1 at A includes a winding 13 of the neutralizing transformer 11, in series with the said line and a winding 14 of the said transformer, which is connected in a branch circuit to ground, the said branch circuit including in addition to the winding 14, a condenser 42 and a resistance 43. Similarly, at station B, the terminal circuit of the line 1 includes a series winding 15 of the transformer 12 and another winding 16, which is connected in a branch circuit to ground, the said circuit including in addition to the winding 16 a condenser 48 and a resistance 49. The transformers 11 and 12 serve to link inductively the line circuits 1 and 2. These circuits are also linked together by means of the transformers 23 and 24, of which the windings 25 and 27, respectively, are connected in series in the line 1, and the windings 26 and 28 respectively in series with the line 2. The windings of transformers 23 and 24 are so arranged that the flow of current in a definite direction in one of said windings will produce a flow of current in the opposite direction in the other winding of the said transformer. The line 1 is connected with the terminal circuits by means of the composite sets 17 and 18, the former of which comprises a series induc-

tance 19 and a shunt capacity 20, and the latter a series inductance 21 and a shunt capacity 22.

The line circuit 2 has connected therewith at station A a key 30, a battery 31, and a resistance 32 and line relay 33, and similarly at station B a key 34, a battery 35, of opposite polarity to battery 31, a resistance 36 and a line relay 37. Furthermore, at station A the terminal circuit has connected therewith a series winding 38 of the transformer 11, and a shunt winding 39, which is in a branch circuit to ground, including the condenser 44 and resistance 45. Similarly at station B the terminal circuit includes a series winding 40 of the transformer 12 and a shunt winding 41, which is in the branch circuit to ground, including the condenser 46 and the resistance 47. The line circuit 2 is connected to its respective terminal circuits by means of the composite sets 50 and 51, which comprise the series inductances 52 and 54 respectively and the shunt condensers 53 and 55 respectively.

The manner in which the receiving-end and the sending-end cross-fire may be reduced or prevented will be clear from the following description of what occurs when signals are transmitted over the line 1 from the station A to station B, while the line circuit 2 is idle. For such conditions, key 7 of the line 1 at station B will remain closed and the key 3 at station A will be operated for the transmission of signals. Keys 30 and 34, connected with the line 2, will remain closed, which is the normal position of such keys when a circuit of this type is idle. Let it be assumed that key 3 has just been closed for the transmission of a marking signal over the line 1. Current will flow along the line 1 in the direction represented by the solid arrows. This current will flow through the windings 13 and 25 and 27 and 15 in series. Current will also flow through the winding 14 of the transformer 11 to ground in the direction shown by the solid arrow, and likewise will flow through the winding 16 of the transformer 12 to ground. The magnitude of the current flowing, for example, through the winding 14 to ground may be varied by adjusting the condenser 42 and the resistance 43 in series with the said winding, and consequently, this current may be made greater or less than the current flowing through the winding 13. Since these windings are in parallel opposition the flux produced by the respective currents will be in opposition so that if the currents are unequal, a resultant flux in either one direction or the other will occur, depending upon the winding in which the greater current flows. Let it be assumed for the purpose of description that the current flowing through the winding 13 is greater than that through the winding 14, so that the resultant flux will be shown by the crossed arrow within the core of the transformer. This flux will induce in the windings 38 and 39 a difference of potential such as to cause a flow of current in the said windings in the direction represented by the dotted arrows. A similar result will occur in connection with the transformer 12, wherein a resultant flux, as represented by the crossed arrow, will produce in the windings 40 and 41 a difference of potential such as to cause a current flow in the direction represented by the dotted arrows. The flow of current through the windings 25 and 27 of the transformers 23 and 24 will produce a flow of current in the opposite direction, also shown by the dotted arrow, in the windings 26 and 28.

The transmission of the signaling impulse over the line 1 will produce an interfering current in the line 2, which will flow therein in the directions represented by the wavy arrows toward the grounds at the terminals of the said line. The flow of interfering current toward the terminal B of line 2 will be substantially eliminated by the flow of current in opposite direction, as shown by the dotted arrows, which thereby prevents the said interfering current from producing any effect upon the receiving relay 37, connected with the disturbed circuit at the station B. Since, however, the interfering current and the neutralizing current are flowing in the same direction toward the station A, a greater effect would be produced, upon the receiving relay 33 than if no neutralization had been attempted, were it not for the presence of the neutralizing transformer 11 which is designed to afford protection for the sending-end receiving apparatus. As has been stated heretofore, the production of a resultant flux in the transformer core, as represented by the crossed arrow, will produce a difference of potential in the windings 38 and 39, such that the resultant current in the said windings will be in the directions represented by the dotted arrows. There will accordingly result a flow of current in the direction from the battery 31 through the resistance 32, key 30, relay 33, winding 39, condenser 44, resistance 45, to ground, the direction of which current is opposite the direction of the neutralizing current produced by the transformers 23 and 24, and also opposite in direction to the interfering current flowing from the line 2 towards the terminal A. By the proper adjustment of the condenser 44 and the resistance 45 the magnitude of the current flowing in the circuit just traced may be proportioned so as to effect the entire neutralization of the interfering current and of the neutralizing current that flows in the direction from the line 2 towards the ground at the terminal A.

It will be seen, therefore, that by means of the arrangement shown in the attached drawing, which combines the effects of the transformers 11 and 23, and 12 and 24, associated with the terminal circuits of the line circuits, complete neutralization of both the receiving-end cross-fire and the sending-end cross-fire in grounded telegraph circuits may be entirely effected.

Whereas this invention has been shown applied to a system embracing only two circuits, it is to be understood that it is not so limited, since it may be applied to a system embracing any greater number of circuits; and, as applied, it will function in the same manner as it does in the system heretofore described and shown.

Furthermore, although this invention has been disclosed as embodied in a particular form and arrangement of parts it is to be understood that it is not thus limited but is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a single-line Morse telegraph system, the combination with a plurality of line circuits of terminal circuits connected with each end of the said line circuits, and a multi-winding transformer having windings connected in series with the said line circuits and also windings connected between each of said line circuits and ground for neutralizing interfering currents of the said line circuits.

2. In a single-line Morse telegraph system, the combination with a plurality of single-line Morse telegraph circuits of a multiwinding transformer having groups of windings connected therewith, each group being connected with a line circuit in such manner that one winding of a group will be in series with its line circuit and the other winding in shunt to ground.

3. In a single-line Morse telegraph system, the combination with a plurality of line circuits, each having terminal apparatus connected therewith, of a transformer having groups of windings connected therewith, one winding of each group being connected in series with a line circuit and the other winding of each group being connected in shunt to ground, the circuits of the said windings being so arranged that the flux resulting from the transmission of a signaling impulse over one of said line circuits will create in the other windings of the other group an electromotive force such as to neutralize interfering cross-fire set up in the other circuit connected with the said latter group of windings.

4. In a single line Morse telegraph system, the combination with a plurality of line circuits, of terminal circuits connected with each end of the said line circuits, a multi-winding transformer having windings connected in series with each of said line circuits and also having windings connected between each of the said line circuits and ground, and a second transformer having a plurality of windings each individual to and connected in series with one of the said line circuits whereby the receiving-end and the sending-end crossfire may be substantially neutralized.

5. In a single line Morse telegraph system the combination with a plurality of single-line Morse telegraph circuits of a multi-winding transformer having groups of windings connected therewith, each group being connected with a line circuit in such manner that one winding of a group is in series with its line circuit and the other winding in shunt to ground, and a second transformer having a plurality of windings each individual to and connected in series with one of said line circuits whereby the receiving-end and the sending-end crossfire may be substantially neutralized.

In testimony whereof, I have signed my name to this specification this 5th day of May, 1922.

SAMUEL I. CORY.