

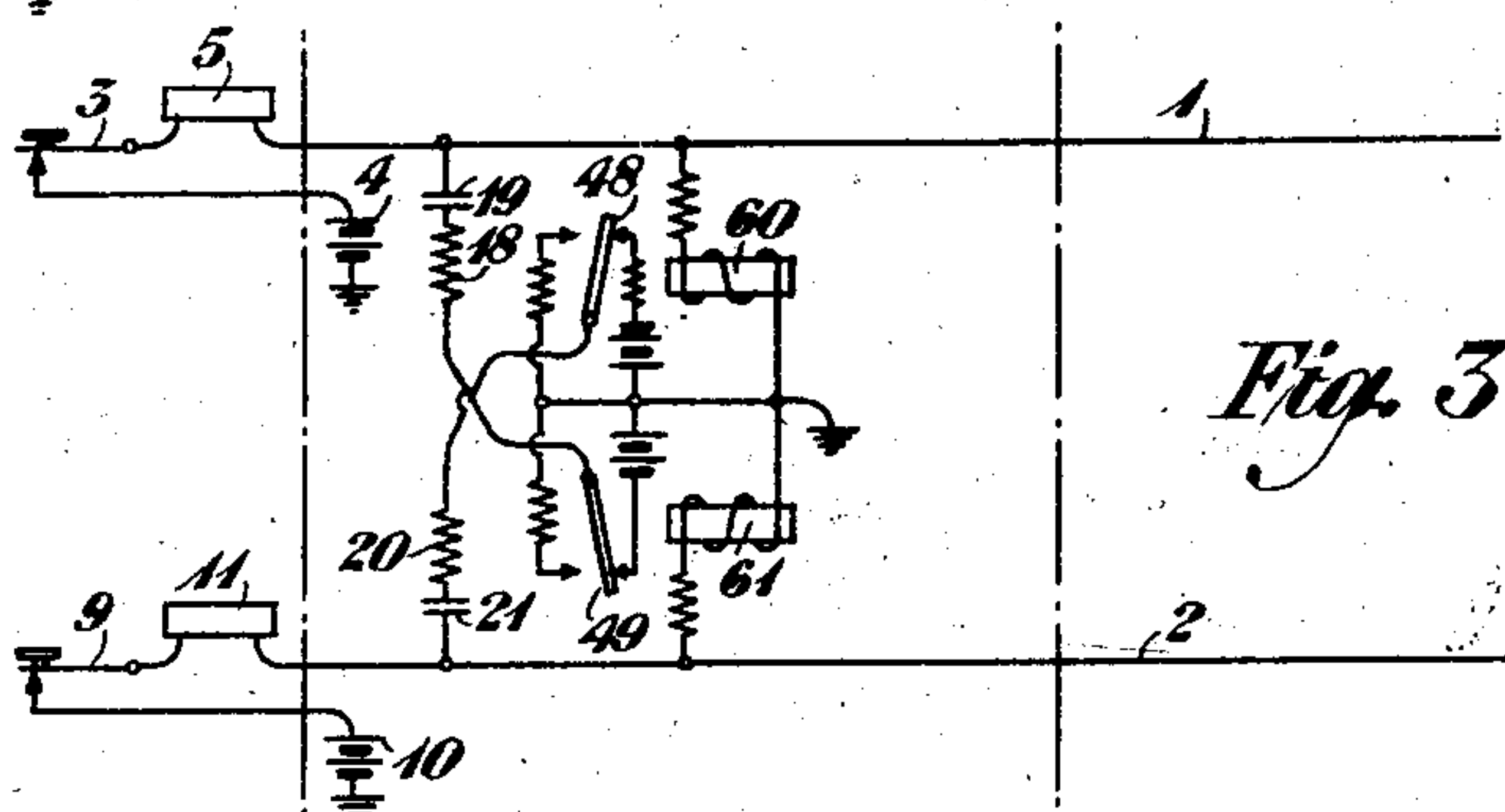
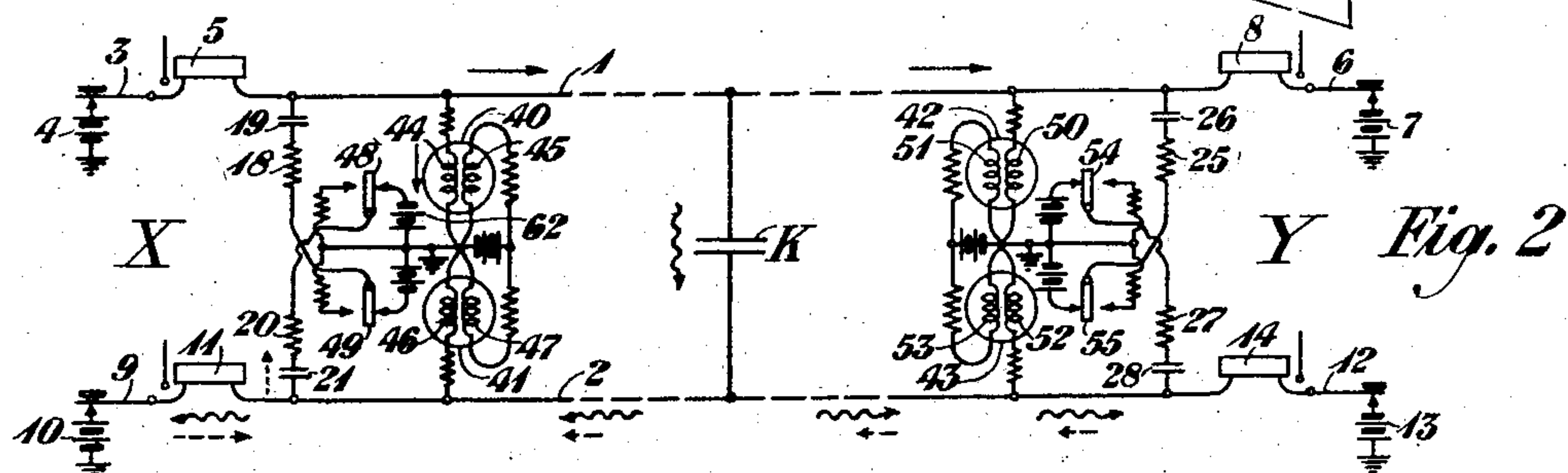
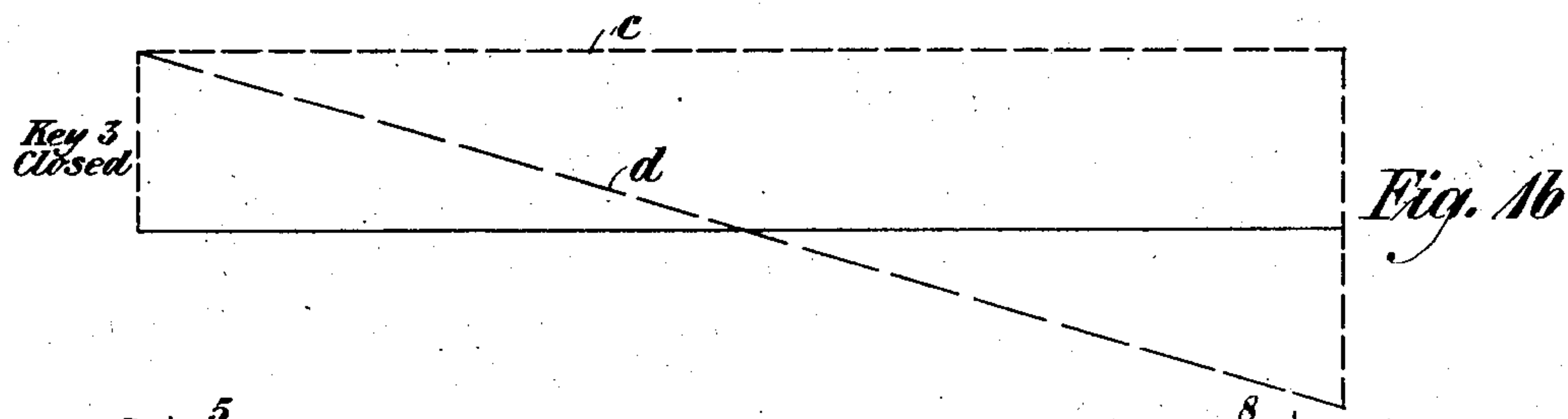
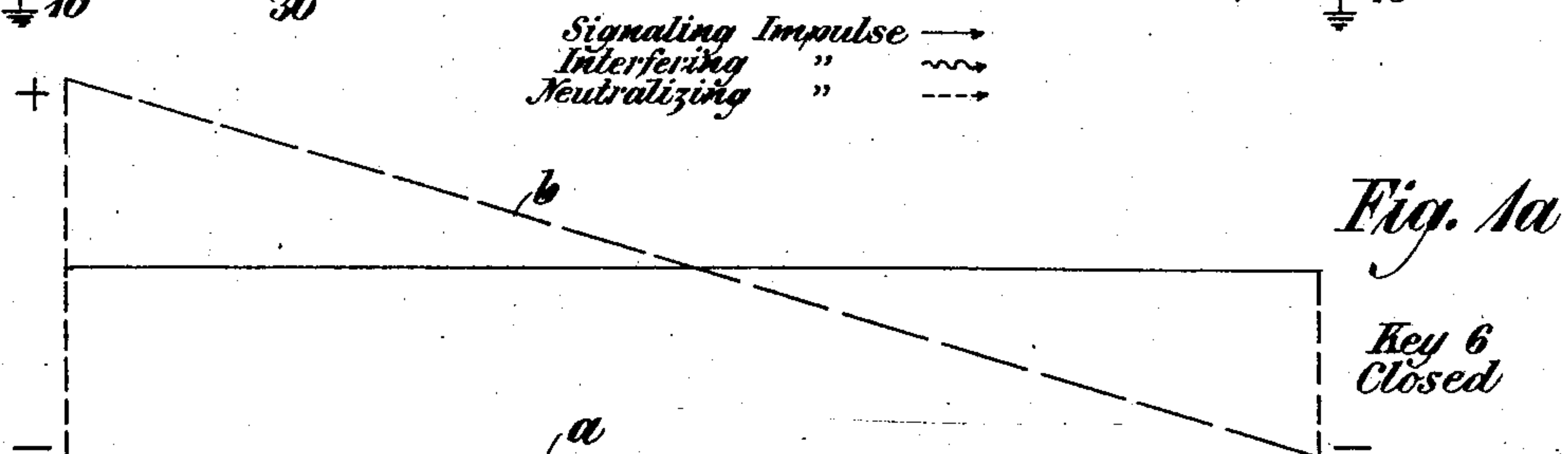
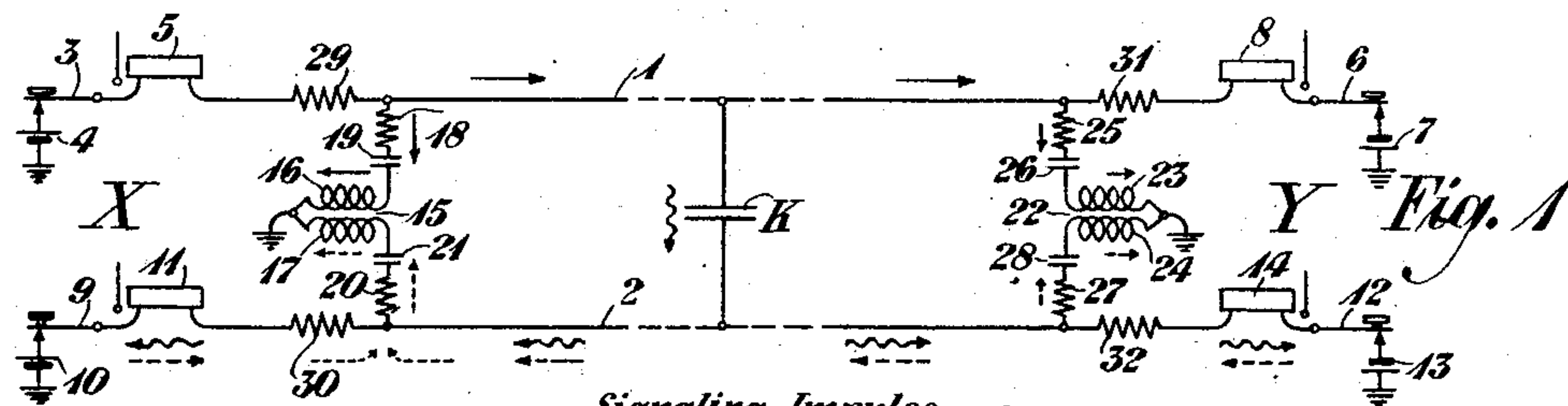
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MEANS FOR REDUCING CROSS FIRE IN TELEGRAPH CIRCUITS

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MEANS FOR REDUCING CROSS FIRE IN TELEGRAPH CIRCUITS.

Application filed April 27, 1922. Serial No. 556,876.

To all whom it may concern:

Be it known that I, JOHN M. FELL, a citizen of the United States, residing at Hackensack, in the county of Bergen and State of New Jersey, have invented certain Improvements in Means for Reducing Cross Fire in Telegraph Circuits, of which the following is a specification.

This invention relates to means for neutralizing cross-fire in grounded telegraph circuits, and particularly to an arrangement to neutralize electrostatic cross-fire in the disturbed circuits of a system, due to potential changes in the disturbing circuit.

In the transmission of signals over a grounded telegraph circuit which forms one of a group of circuits extending substantially parallel to each other, currents of an interfering nature are set up in the other circuits of the group by virtue of the mutual admittance between the various circuits.

When the disturbing line has its potential changed in a positive direction, as on the closing of the line due to a marking signal sent from the "home" end, i. e., the end having a positive line battery, the interfering current flows towards the disturbed circuits. Here it divides and flows towards each end of the said circuits, the magnitude of the currents in the two directions depending on the magnitude of the impedance of each of these circuits from its midpoint to the grounding points at its ends. As the potential along the disturbing line is restored to its original value and direction, which occurs on the opening of the line when a spacing signal is sent from the "home" end, the interfering current will reverse and will flow in the disturbed circuits from their grounded ends towards their midpoints and thence to the disturbing line. The direction of flow is reversed in each of the above described cases when marking and spacing signals respectively are sent from the "distant" end of the disturbing line which has a battery opposite in polarity to that of the "home" end discussed above.

These interfering currents affect the relays or other signal responsive apparatus at the terminals of the disturbed circuits, and impair transmission.

It is the object of this invention to neu-

tralize the effect of interfering currents upon the signal responsive apparatus at the terminal circuits by transmitting simultaneously through such apparatus neutralizing currents opposite in direction and substantially equal in value to the interfering currents.

This invention will be better understood from the following description when read in connection with the attached drawing, of which Fig. 1 shows a form of embodiment of the invention in which neutralization is effected by means of an inductive coupling between the leak circuits of the various line circuits, and Figs. 1^a and 1^b show the potential gradients for various operating conditions; Fig. 2 shows an arrangement using polarized relays in the leak circuits to effect neutralization, and Fig. 3 shows the use of neutral relays to effect the desired result.

In Fig. 1, 1 and 2 represent two line circuits having connected therewith means for effecting the desired neutralization which constitutes one form of the invention. Any number of line circuits might be so inter-related but the description will be simpler and clearer if confined to two line circuits and their associated apparatus as shown in the figure. The line circuit 1 has connected therewith at station X a key 3, a battery 4, a line relay 5, and a current limiting resistance 29. Similarly, at station Y there are connected to the circuit 1 a key 6, a battery 7, the polarity of which is opposite to battery 4, a line relay 8, and a current limiting resistance 31. The line circuit 2 has connected therewith at station X a key 9, a battery 10, a line relay 11 and a current limiting resistance 30, and similarly at station Y a key 12, a battery 13, the polarity of which is opposite that of battery 10, a line relay 14, and a current limiting resistance 32. The mutual admittance is represented by a condenser K connected by dotted lines between the two line circuits. Each of the said line circuits has connected therewith a leak circuit to ground. Thus, at station X, line 1 has connected therewith a resistance 18 in series with the condenser 19 and one of the windings 16 of a transformer 15; and similarly line 2 has connected therewith a resistance 20 in series with a condenser 21, and the winding 17 of the transformer 15. A

similar neutralizing transformer 22 is connected with the leak circuits at the station Y. One of the windings 23 of this transformer is connected in series with the resistance 25 and the condenser 26, and the other winding 24 in series with the resistance 27 and the condenser 28.

Having in mind the foregoing description of the circuit the invention will be clear from the following description of its mode of operation.

For the purpose of description let it be assumed that signals are being transmitted over the line 1 at a time when the line 2 is unoperated, that is to say, when the keys 9 and 12 are closed. Not only will this result in grounding both terminals of the line circuit through the batteries 10 and 13, but a steady current will flow over the line 2. This will produce no abnormal effect upon the signal apparatus connected with this circuit. However, as a result of the transmission of signaling impulses over the line circuit 1, interfering currents will be set up in circuit 2 which it is the object of this invention to neutralize so that no effect will be produced by them upon the signal receiving apparatus. Furthermore, let it be assumed that the key 3, connected with the line 1, is closed to transmit a marking signal to the distant station Y. Just prior to the closing of this key the line circuit 1 was at a definite negative potential, represented by the dash line *a* in Fig. 1^a, since the negative battery 7 remained connected to the line. By the closing of the key 3 the potential of the end of the line near X was changed from a negative value to a positive value so that the potential gradient along the line 1 is represented by the line *b* in Fig. 1^a. It should be observed that the potential change which is represented by the distance between *a* and *b* is quite large near station X and diminishes toward station Y so that the effect of this changing potential, which manifests itself in the current flowing in line 2, is greater near station X than near station Y. The effect of impressing the positive potential upon line 1 by the closing of the key 3 will cause an interfering current to flow to line 2, which is represented by the wavy arrow, which interfering current will divide and flow to ground at each end of the line 2.

This interfering current would normally produce an effect upon the relays 11 and 14 unless it were neutralized, which may be effected as follows: When the signaling impulse was transmitted over line 1 by the closing of the key 3, current flowed through the leak circuit of line 1 to ground, containing the winding 16, in the direction shown by the solid arrow. The winding 16 bears such relation to the winding 17 that the potential induced therein will cause a

flow of current in the direction represented by the dotted arrow. The establishment of this difference of potential in the winding 17 will cause a flow of current in the circuit containing the battery 10, key 9, relay 11, resistances 30 and 20, condenser 21 and winding 17. The direction of this flow of current will be as represented by the dotted arrows. It will be seen, therefore, that this neutralizing current opposes the interfering current in relay 11 and thereby minimizes the effect of the interfering current upon this relay. The induction of the potential in the winding 17 will also cause a flow of current in the direction represented by the dotted arrows through a circuit containing the battery 13, key 12, relay 14, resistance 32, line 2, resistance 20, condenser 21 and winding 17, to ground. The direction of this current is in opposition to the interfering current flowing through the relay 14 and tends to neutralize the interfering current. The neutralizing transformer 22 will also come into play and produce a neutralizing current which will tend to neutralize the interfering current, although the magnitude of this current will be smaller than that produced by the transformer 15, since the change of potential in the line 1 is smaller at station Y than at X. This is clearly seen from the curves *a* and *b* of Fig. 1^a. The flow of current through the winding 23 will be in the direction represented by the solid arrow, which will induce a difference of potential in the winding 24, which will cause current to flow in the direction represented by the dotted arrow. The direction of this current will be such as to tend to neutralize the interfering current.

If the key 3 is open for the transmission of a spacing signal, the potential gradient of line 1 will change from *b* to *a*. This results in a change of direction of the interfering currents in the line 2, that is to say, the interfering current will flow from the ground at each end of the line 2, and through the admittance to the line 1. This change in the direction of the interfering current is met and counteracted by the changing of the direction of the neutralizing current. By the opening of the key 3 the potential across the condenser 19 is varied so that current will flow through the winding 16 in direction opposite to that shown by the solid arrow in the drawing. This will result in the induction of a potential in the winding 17, adapted to produce a current opposite in direction to the dotted arrow shown in the drawing. In like manner, the direction of the current in the windings of the neutralizing transformer 22 is changed so that the neutralizing currents in the line circuit are opposed in direction to the interfering currents.

Fig. 1^b shows the potential gradients for

the condition that key 3 remains closed for the reception of signals transmitted by the opening and closing of the key 6 at station Y. Under this condition, the line 1 remains the disturbing circuit and the line 2 the disturbed circuit. The greatest effect, however, would be produced, under this condition, near the station Y because the greater variation of potential difference between the line circuit and ground occurs near Y. The manner in which neutralization is effected is, however, similar to that previously described.

The neutralizing transformers may be located at a central point in the line, or at each terminal, as shown in the drawing. The central location would probably be most efficient as the neutralizing impulses would then divide between the two terminals in about the same proportion as the electrostatic cross-fire impulses are divided. When, however, the neutralizing transformers are located at the terminals it is advantageous to operate the telegraph circuits with higher battery potentials and to limit the currents by means of the resistances 29, 30, etc., located between the battery and the transformer branches. Not only has this the effect of placing the transformer nearer the center of the line but it possesses advantages from the standpoint of practical operation. The transformer branches may be connected permanently to the Morse branches of composite sets, or they may be made a component part of the composite set. In either case, they would tend to neutralize electrostatic cross-fire in any telegraph system operated on a composited circuit. Although the invention is shown connected with a single line Morse circuit, it is adapted for use in connection with duplex or half-duplex circuits. And as has been stated heretofore, the invention is applicable to the neutralization of cross-fire in any number of circuits exposed to a single disturbing circuit. Thus, for example, it is possible to provide a transformer having four windings for use with the four wires of a phantom quad circuit.

The arrangement shown in Fig. 2 employs the use of polarized relays for impressing neutralizing impulses upon an exposed circuit for minimizing electrostatic cross-fire. In this figure, the same reference numerals have been used to represent parts similar to those shown in Fig. 1. Connected with the line circuit 1 is a leak circuit containing the condenser 19, a resistance 18 and the armature 49. Similarly connected to line circuit 2 is a condenser 21, a resistance 20 and the armature 48. When keys 3 and 9 are closed, current flows through the operating windings 44 and 46 of the relays 40 and 41 respectively to ground, which maintains the armatures 48 and 49 in position touching their right-hand contacts, which connects

negative batteries to the said armatures. The windings 45 and 47 of the said relays are adapted to move the armatures 48 and 49 to the left-hand contacts upon the opening of the circuits through the windings 44 and 46. The neutralizing relay circuit at station Y is similar to that at station X and needs little further comment. It should be noted that the batteries connected with the left-hand contacts of the armatures 54 and 55 at station Y are of opposite polarity to similar batteries shown connected to the right-hand contacts of the armatures 48 and 49 at station X.

When keys 6 and 12 are closed, which for example is the situation existing when signals are being received at station Y over line 1, and when line 2 is idle, current flows through the operating windings 50 and 52 of relays 42 and 43 and draws up the armatures 54 and 55 respectively into position touching the left-hand contacts thereof. A charging current will flow into the condensers 28 and 26 respectively until they are fully charged. The relays 42 and 43 will remain operated regardless of changes in the line potential caused by the operation of the keys at station X, so that the armatures 54 and 55 remain in the position shown, so long as the keys 6 and 12 remain closed. It is important that these relays should not respond to the actuation of the distant keys, because, if they did, the batteries connected with the armatures would impress on the line circuits impulses in the same direction as the interfering impulses, which therefore would tend to increase the receiving end cross-fire instead of diminishing it.

When the key 3 was closed, as shown in the figure, a signaling impulse was transmitted over the line 1 in the direction represented by the solid arrows. This will produce an interfering current in the line 2 in the directions represented by the wavy arrows. By the closing of key 3, current flowed through the winding 44 in the direction represented by the solid arrow, which brought the armature 48 into position touching its right-hand contact, thereby establishing a circuit including the battery 10, key 9, relay 11, condenser 21, resistance 20, armature 48, battery 62, which causes a flow of neutralizing current in the direction represented by the dotted arrows. Since there is but slight variation of the potential difference at the point where relay 42 is connected to the circuit as shown by the potential gradients a and b of Fig. 1^a, the said relay will not respond to impulses caused by the operation of key 3. Consequently the armature of this relay will be held by the winding 50 against the left-hand contact, and no change takes place on the circuit containing the condenser 28 and the resistance 27 to ground. The interfering impulse may be neutralized

by the neutralizing current, represented by the dotted arrow, which is created by the neutralizing difference of potential set up in the circuit controlled by the relay 40 at station X.

If the key 3 is opened for the transmission of a "space" signal, the interfering current in the line 2 will be in direction opposite to that represented by the wavy arrows in the figure. By the opening of the said key, current will cease to flow through the winding 44 of the relay 40 and consequently the armature 48 will be moved by the retractive winding 45 into a position touching its left-hand contact. This serves to ground the leak circuit containing the condenser 21 and the resistance 20. The condenser 21 will accordingly give up its energy and the flow of current therefrom will be in the direction opposite to that shown by the dotted arrows in the figure, which direction will tend to neutralize the interfering impulse.

The arrangement shown in Fig. 3 is similar to that shown in Fig. 2 and needs but little additional description. It represents the use of neutral relays in place of the polarized relays shown in Fig. 2. These neutral relays 60 and 61 perform in the same manner the same functions as are performed by the corresponding relays in Fig. 2.

It will accordingly be seen that by means of the invention, which is shown in several forms of embodiment in the attached figures, electrostatic cross-fire between grounded telegraph circuits may be substantially eliminated or greatly minimized.

Although this invention has been shown as disclosed in particular forms it is capable of embodiment in different forms without departing from the scope of the appended claims.

What is claimed is:

1. In a grounded telegraph system comprising a plurality of single-line Morse circuits, having grounded leak circuits inductively related to each other, the method of neutralizing cross-fire between said Morse circuits which consists in impressing signaling impulses upon one of said Morse circuits, allowing part of the signaling current to flow to ground through the leak circuit of the said Morse circuit, and inducing a current in other leak circuits in such direction as to neutralize interfering currents set

up in their associated Morse circuits by said signaling impulses.

2. In a grounded telegraph system, the combination with two grounded telegraph circuits of leak circuits individual to and connected with the said telegraph circuits, said leak circuits having a condenser in series with an inductance, the said inductances being mutually related.

3. In a grounded telegraph system, the combination with two grounded telegraph circuits of leak circuits individual to and connected therewith, the said leak circuits being inductively coupled so that a flow of current in one will induce a current in the other of the said leak circuits, the direction of the induced current being such as to neutralize interfering currents set up in that telegraph circuit with which said other leak circuit may be connected.

4. In a grounded telegraph system, the combination with a line circuit having grounded terminal circuits associated therewith, of a second line circuit also having grounded terminal circuits associated therewith, and a plurality of leak circuits individual to and connected with the said line circuits, each of the said leak circuits having a condenser in series with an inductance, the said inductances being mutually related.

5. In a grounded telegraph system, the combination with two grounded telegraph circuits of a plurality of leak circuits individual to and connected with each telegraph circuit at each end thereof, each of said leak circuits having a condenser, and each pair of said leak circuits at the same point on their respective line circuits being inductively connected together so as to produce neutralizing impulses whenever signaling impulses are transmitted over the other of said telegraph circuits.

6. In a grounded telegraph system, the combination with a plurality of line circuits having grounded terminal circuits associated therewith of a plurality of leak circuits individual to and connected with the said line circuits, each of said leak circuits having a condenser in series with an inductance, all of said inductances being mutually related.

In testimony whereof, I have signed my name to this specification this 25th day of April, 1922.

JOHN M. FELL.