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NULLIFYING DISTURBANCES IN TELEGRAPHIC OR OTHER SIGNALING CIRCUITS.

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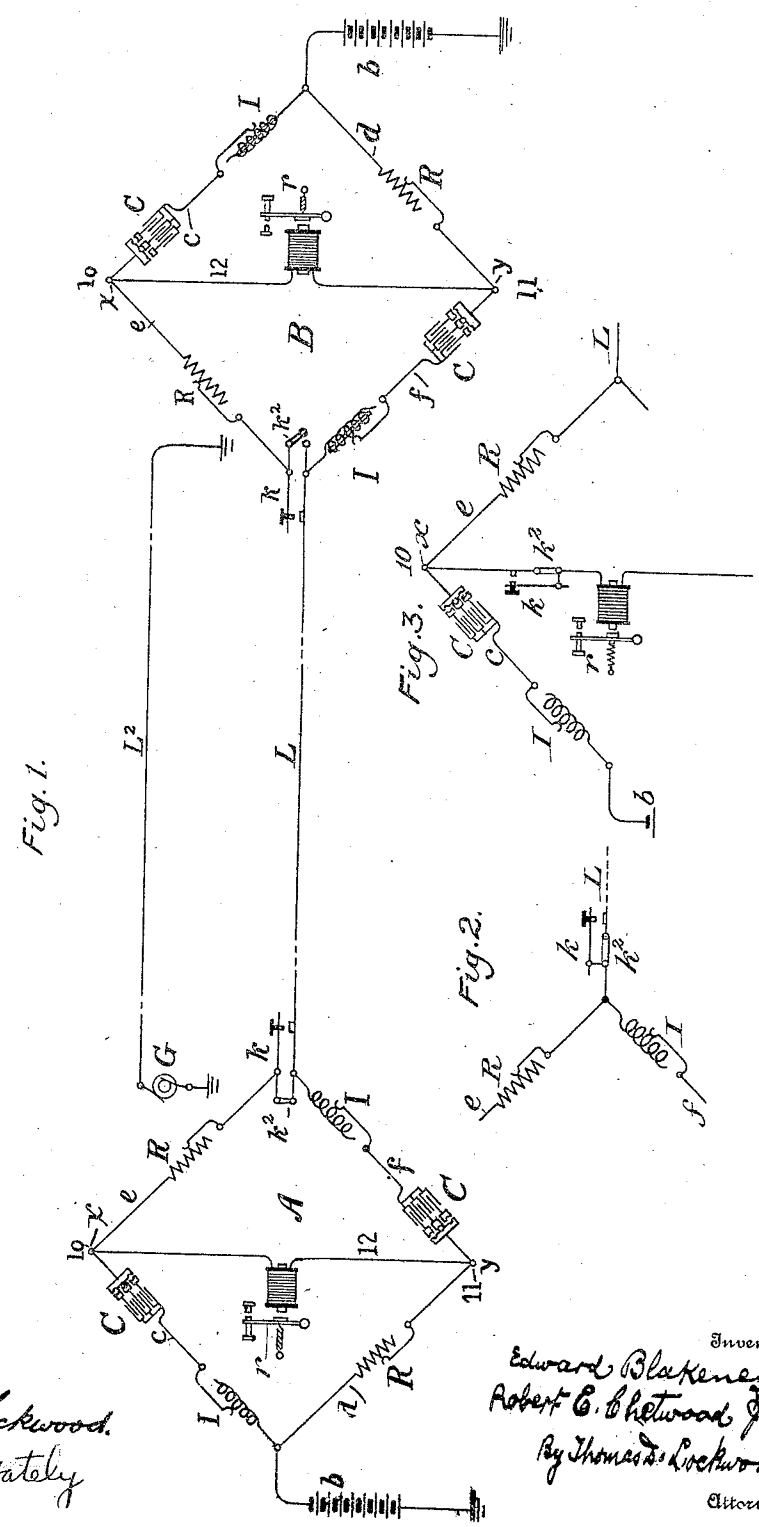

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NULLIFYING DISTURBANCES IN TELEGRAPHIC OR OTHER SIGNALING CIRCUITS.

No. 874,826. Specification of Letters Patent. Patented Dec. 24, 1907.

Application filed May 29, 1906. Serial No. 319,388.

To all whom it may concern:

Be it known that we, EDWARD BLAKENEY and ROBERT E. CHETWOOD, Jr., residing at Ossining and Elizabeth, in the counties of Westchester and Union and States of New York and New Jersey, respectively, have invented certain Improvements in Nullifying Disturbances in Telegraphic or other Signaling Circuits, of which the following is a specification.

This invention has reference to the separation of currents of different characters flowing in electrical circuits, and particularly to the nullifying of such disturbances as may be produced in telegraphic or other signaling circuits by the inductive effect of an adjacent circuit carrying an alternating current.

Considering a telegraph system in which the relays or other receiving elements are operated by the presence or absence of direct current, it being organized for operation by the normal slowly recurring current impulses of standard Morse signals manually transmitted, if the line has near it a conductor through which passes an alternating current, a similar current will be induced in the telegraph-line which will be superposed upon the operating current. A class of alternating current which is at the present time often encountered is that of single phase and of comparatively low frequency yet high relatively to Morse transmission, say 25 cycles per second, which is employed for power transmission. The electromotive forces producing such currents are usually extremely high, and, of course, change abruptly from their maximum value to zero, giving powerful inductive effects, yet the frequency is not so great but that the armatures of the relays can follow the alternations induced in the line. As a result the operating current assumes such a undulatory character that the signals are distorted and confused by the vibration of the armatures. To exclude the alternating current from the telegraphic receiving elements and thus prevent this disturbance, and to provide a system by which signals may be effectively transmitted and received without interference or confusion are the principal objects of the invention.

It consists in a means for furnishing separate paths for and confining thereto currents of diverse characteristics, that which is herein disclosed being in the form of a balance circuit with which the receiving element is associated and which excludes alternating current from said receiving element by virtue of the establishment of a condition of equipotential at the extremities of a bridge or cross conductor in which it is placed, while the bridge is thrown out of equilibrium for operating currents and made a portion of their exclusive path by the presence of inductive devices in a portion of the branches of the balance circuit to which telegraph currents are relatively impassable.

In order that the invention may be more readily understood, reference is had to the accompanying drawings.

Figure 1 illustrates diagrammatically a telegraph system arranged in accordance with the invention. Figs. 2 and 3 illustrate alternative positions of the transmitting key in the circuit.

Referring to Fig. 1, the letters A and B designate telegraph stations provided with sending and receiving elements k and r, respectively, to be hereinafter more particularly referred to, and between which extends a line conductor L. This conductor is shown as grounded at its extremities to complete the main circuit, though obviously a complete metallic circuit could be substituted if desired, and contains batteries b or other suitable sources of operating current.

Situated in such proximity to the line as to act inductively upon it, is shown a conductor L^2 constituting, for example, a portion of a power-circuit and carrying an alternating current flowing from a generator or other source G, which is of such periodicity that a disturbance will be produced in the telegraph line prejudicial to its operation.

To nullify the effect of parasitic or disturbing currents and prevent the receiving instruments r, which appear conventionally in the drawings as relays, from being affected thereby, the line L at each station is divided, there being two conductors 10 and 11 connected in parallel to form a section or extension of the main circuit they being in series therewith. These parallel branches of the line are separated into portions c, d, e and f by a bridge-conductor 12 connecting the points x and y in the conductors 10 and 11, respectively, and in the bridge-conductor of each station is connected its relay r. Each of these portions c, d, e, and f when referred to in either the description or claims, is to be understood as comprising all elements of the circuit, conductive or inductive, which connect the line from one side of the balance with a terminal of the bridge conductor. The transmitting element or key k is preferably in the portion e of the conductor 10 for a reason which will later appear.

It will be seen that each of the station-circuits just described is arranged in the manner of a Wheatstone-balance, the portions c, d, e, f of the conductors 10 and 11 furnishing the sides, while the conductor 12 provides the cross-wire or bridge. As is well-known, when the fall of potential in, say, the side c of the balance is to that in the side e as the fall in the side d is to that in the side f, the points x and y will be of equal potential and no current will flow through or rather the electromotive forces are balanced in the bridge. Therefore, to nullify the disturbing effect of the energy existing in the conductor L^2, while still permitting telegraphic operation, it is only necessary to secure equality of potential for alternating currents, while for direct currents the bridge is unbalanced. This result may be attained by so adjusting the impedance of each side that with reference thereto the equation $\frac{c}{d}=\frac{e}{f}$ will be satisfied, and by employing in the conductors 10 and 11 at opposite sides of the bridge inductive devices such as condensers which are opaque or impassable to direct currents while transparent or permissive to alternating currents, and including in the companion sides impedance devices allowing currents of both characteristics to pass. In each of the sides c and f of the balance-circuit are shown coils I possessing both resistance and inductance, this being preferably adjustable, and in series with the coils I in diagonally opposite portions of the parallel branches are condensers C which are shown as being of variable capacity. In each arm d and e is a suitable resistance R, also preferably adjustable, which may or may not be inductive, as is most convenient. When the impedance in the various sides is balanced in the manner previously stated, the bridge 12 will be neutral to the induced alternating currents, which will flow through both parallel conductors 10 and 11 passing inductively through the condensers, and to ground through the battery, leaving the relays unaffected. But upon making and breaking the main circuit by means of one of the keys the impulses will pass through the line, and since the condensers are conductively discontinuous for, or are impassable to direct slow-changing currents, the circuit is unbalanced as far as these are concerned and they flow excusively through the sides d and e and the bridge-connection those constituting the sole conducting path through the balance circuit, and operate the relays in the usual manner.

In balancing the circuit the frequency of the disturbing current should be considered, and, as this is liable to vary, such values of resistance, inductance and capacity should be chosen as will not greatly disturb its equation if slight changes in frequency occur. This may be determined experimentally, or mathematically by use of the formula:

$$\text{Impedance}=\sqrt{r^2+\left(\frac{1}{2\pi nc}-2\pi nl\right)^2}$$

by substituting various values of resistance (r), inductance (l), and capacity (c), until such are found that the impedance will vary but little for the expected fluctuation in the frequency (n). In any event the resistance in the sides d and e should be kept as low as possible to avoid cutting down the operating currents they carry. Also, if practical, that is if such devices for any specific case are not unduly large, air-core coils may preferably be used in the sides c and f, as is illustrated at station A, since their inductance is reasonably constant within a wide range of practical conditions, and with non-inductive resistance in the arms d and e the circuit would remain substantially balanced for any particular frequency, regardless of the magnitude of the induced current. It may be found, however, that to secure the necessary inductance air-core coils are too cumbersome, and in such case those having iron cores may be employed as is shown at station B.

There are four portions of the circuit in which each of the keys k may be placed to effect the transmission of signals—in the bridge 12, Fig. 3, in the line outside the balance-circuit, Fig. 2, or in either one of the sides d or e which the operating currents traverse. If located in the first-named position the key is shunted by two circuits of large capacity furnished by the arms $c\ d$ and $e\ f$, respectively, so that although the relay of the sending-operator may respond properly, that of the distant station will be sluggish. With the key in the line, if the circuit is not properly balanced some of the alternating current may pass through the bridge and the operating current therein becomes more or less undulatory. This being the case the action of the relay is liable to be irregular, as the key may be closed, considering the extremes, at either the period of maximum or minimum current. The most advantageous location for the key is in one of the sides d or e, since when said key is open the condenser in the other branch conductor is charged by the line batteries and upon closure is discharged, giving a strong current impulse which is sufficient to overcome any lagging tendency of the line current. In connection with each of the keys is shown the usual circuit closer or switch k^2 by which the continuity of the circuit may be preserved when the operators are not transmitting. The switch at the station B appears as open, or in the position for transmission.

Having thus described the invention, we claim:

1. In a telegraphic circuit organized for operation by the slowly recurring current impulses of manually transmitted Morse signals, the combination of a line conductor; branches in parallel with one another forming jointly an extension of said line conductor in series therewith; a bridge conductor uniting said parallel branches; an inductive connection in each parallel branch on different sides of the said bridge, respectively, rendering such portion of each branch impassable to steady currents and to the said slowly recurring normal current impulses, but permitting the passage therethrough of relatively high frequency induced alternating currents; and means for maintaining a potential difference at the extremities of said bridge for the said normal currents, and a condition of equipotential for said induced currents.

2. A telegraph system comprising a main circuit, a Wheatstone-balance system having its branches connected in the main circuit, a receiving instrument in the bridge of the balance, and a condenser connected in a portion of each branch at each side of the bridge, and rendering said portions impassable to steady currents.

3. A telegraphic system comprising a main circuit, a Wheatstone-balance circuit having its branches connected in the main circuit, a receiving device in the bridge of the balance, a condenser connected in a portion of each branch at each side of the bridge, and rendering said portions impassable to steady currents and means associated with the branches for adjusting the balance, substantially as described.

4. The combination in a telegraphic circuit with a line conductor, of parallel conductors forming an extension thereof, a bridge conductor connecting the parallel conductors, a receiving element in the bridge conductor, a condenser in each of the said parallel conductors, said condensers being upon opposite sides of the bridge conductor, respectively, and a sending element in one of the parallel conductors at the opposite sides of the bridge conductor from the condenser.

5. In a system for nullifying the disturbing effects in telegraphic circuits organized for operation by the normal slowly recurring current impulses of standard Morse transmission, of induced alternating currents of relatively high frequency, the combination of the telegraph line conductor; with an inductive circuit station section for the said higher frequency induced currents, comprising two parallel branches each composed of a conductive and an inductive portion in series, the said inductive portion being conductively discontinuous; a conductive circuit station section for the said normal telegraphic currents constituted of the conductive portions of said parallel branches, and an interposed bridge or cross conductor joining said parallel branches at points equipotential with respect to said higher frequency induced currents and between the conductive and inductive portions thereof, said conductively discontinuous inductive portions being on different sides of the bridge in their respective parallel branches; and a receiving telegraph instrument connected in the said bridge.

6. In a system for nullifying the disturbing effects of induced currents in telegraphic circuits, the combination of the telegraph line with an inductive circuit station section for said induced currents comprising two parallel branches each composed of a conductive and an inductive portion in series, a conductive circuit section for the telegraphic currents composed of the conductive portions of said parallel branches, and an interposed bridge or cross-conductor joining points of said branches equipotential with respect to said induced currents, a receiving telegraph-instrument connected in the said bridge, and a transmitting instrument in one of the conductive branch portions.

7. In a system for nullifying the disturbing effects in telegraphic circuits of induced currents of frequency higher than that of the operating telegraphic currents, the combination with the telegraph line, and a station receiving instrument therefor; of a station circuit arrangement organized as a Wheatstone-balance, with condensers in diagonally opposite portions of the parallel branches of the said balance rendering such portions conductively discontinuous; the said receiving instrument being connected in an operative circuit constituting the sole conductive path through the Wheatstone-balance, and composed of the bridge and the other two diagonally opposite portions thereof in series, as described herein.

8. In a system for nullifying the disturbing effects in telegraphic circuits of induced currents having a frequency higher than that of the normal operating currents, the combination with the telegraph line, and a station receiving-instrument therefor; of a station circuit arrangement comprising two parallel branches and a bridge conductor joining them and thus organized as a Wheatstone-balance; and condensers in diagonally opposite portions of the said parallel branches rendering such portions conductively discontinuous, and constituting of the other two diagonally opposite portions of said branches and the bridge conductor the sole conducting

path through the said balance; the said receiving instrument being connected in the bridge conductor between parallel and equipotential points in the paths of said higher frequency induced currents, and in series in the said sole conducting path of the normal telegraphic currents, whereby the said instrument is made responsive to the said normal currents only, substantially as specified.

In testimony whereof, we have signed our names to this specification in the presence of two subscribing witnesses, this twenty fifth day of May 1906.

EDWARD BLAKENEY.
ROBERT E. CHETWOOD JR.

Witnesses:
MILLS E. CASE,
HARRY H. BRIGHAM.