J. A. BARRETT.

SYSTEM FOR NULLIFYING INDUCTIVE DISTURBANCES.

APPLICATION FILED APR. 29, 1908.

940,658. Patented Nov. 23, 1909.

2 SHEETS—SHEET 1.

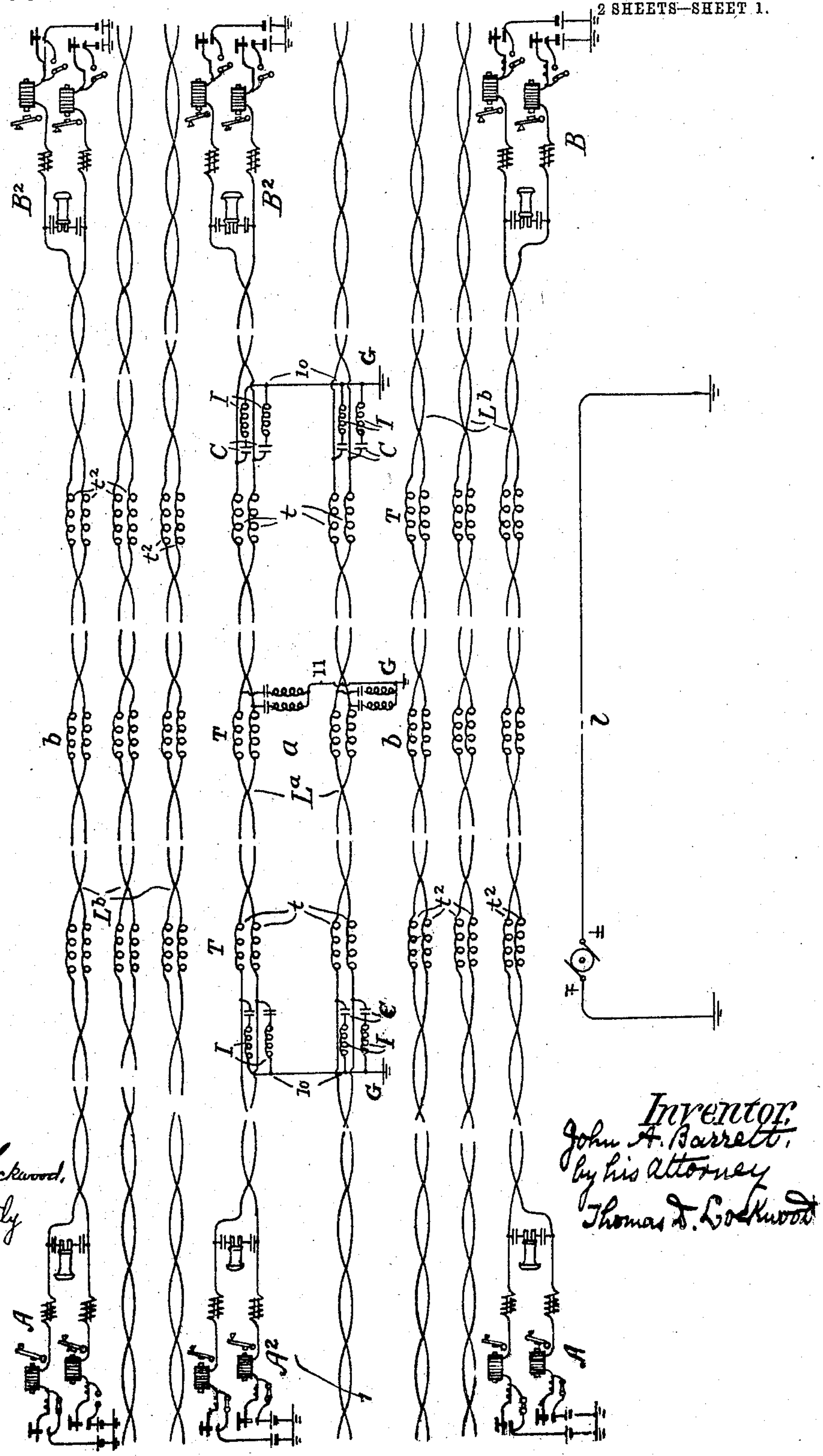

Fig. 1.

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2 SHEETS—SHEET 2.

Fig. 2.

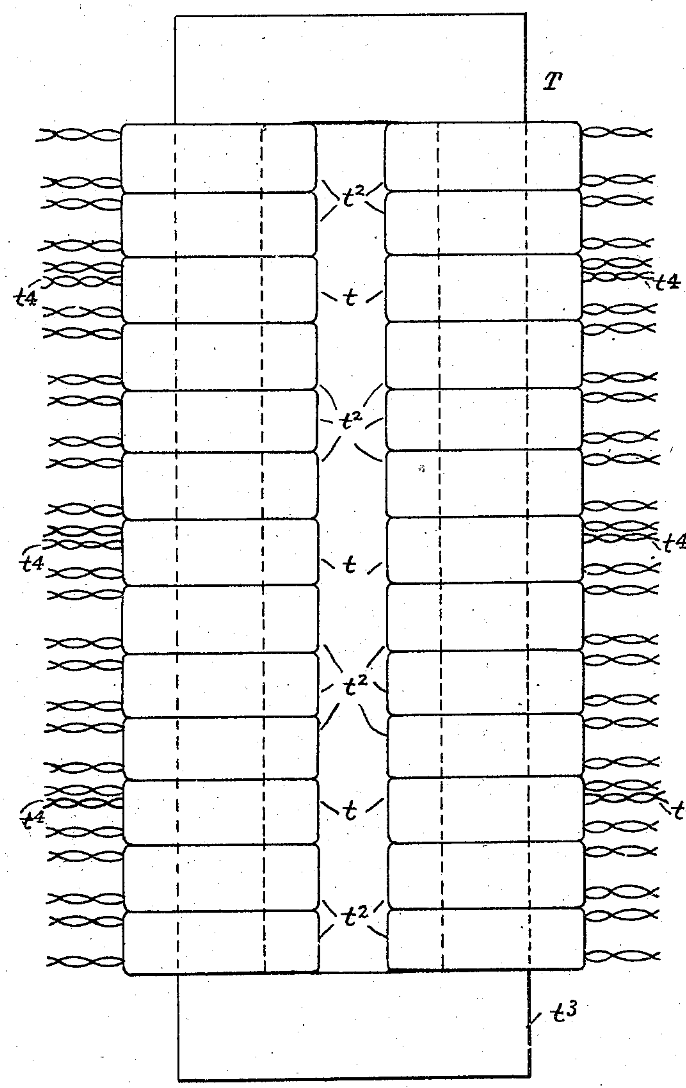
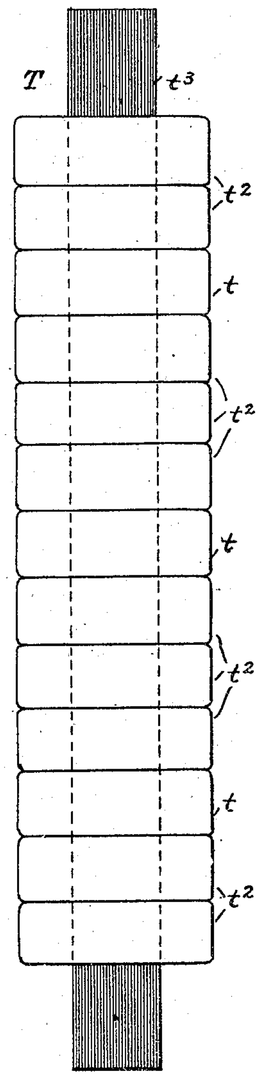


Fig. 3.



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UNITED STATES PATENT OFFICE.

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SYSTEM FOR NULLIFYING INDUCTIVE DISTURBANCES.

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Application filed April 29, 1908. Serial No. 429,970.

To all whom it may concern:

Be it known that I, JOHN A. BARRETT, residing at New York, borough of Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Systems for Nullifying Inductive Disturbances, of which the following is a specification.

Circuits for telephonic and telegraphic communication, or other lines over which electrical signals are transmitted under comparatively low potentials, are liable to be subjected to inductive disturbance arising from sources external to their system, as alternating current power circuits such as are concerned in the propulsion of heavy railway trains at high speeds. These power systems frequently operate with excessive currents and at a relatively low frequency, say twenty-five cycles, and have been found to set up in adjacent conductors electromotive forces often amounting to from one hundred and fifty to three hundred volts, and sometimes attaining much higher values. Under such conditions a grounded telegraphic circuit, as usually organized, is rendered inoperative, the induced twenty-five cycle current, even if not under much pressure causing the relay armatures to so vibrate that the Morse signals are rendered unintelligible. With metallic circuits, as those of the telephone, no matter how carefully they are transposed, they still may be seriously affected when the induced electromotive force reaches about two hundred volts, since it then begins to discharge at the lightning arresters, and to the disturbance thus produced is added the hazard of fire from insufficent insulation and of painful shocks to subscribers and operators. To prevent these difficulties, it has been proposed to diminish the inductive effects by applying to the disturbed conductors opposing electromotive forces generated in the plural secondary windings of one or more properly designed induction coils, there being one of these secondary windings connected in each signaling conductor, while a primary winding for inducing in the secondaries the neutralizing electromotive forces is in a circuit under the same inductive influence as said signaling conductors. To attain the best results the resistance of the primary circuit of each induction coil must be low, and therefore the primary winding has consisted of a conductor of relatively large cross section. To continue this low resistance throughout the circuit of the primaries, the conductors making up the remainder of this neutralizing circuit must also be of small resistance and since, as already pointed out, their exposure must be the same as that of the lines in which disturbances are to be abated, it has been found convenient to set aside from the latter a sufficient number to give the requisite conductivity, connecting these in multiple to each primary winding and grounding their extremities outside the affected district to permit a flow of the primary neutralizing current. It will be evident that the lines thus employed are useless for the purposes for which they were intended, since their connection with the signal primary winding makes them in effect a signal conductor and the ground connections carry off the signal-ing as well as the neutralizing currents. There must consequently be counted against this system, in addition to the comparatively small investment in induction coils, charges for the neutralizing conductors amounting to at least twenty five per cent. of the expenditure for those protected. Though a gain is made, it is at a heavy cost, and the purpose of the present invention is to minimize this loss in conductors.

With this end in view, my invention consists in a means of utilizing for transmission, as by telephony or telegraphy, the primary conductors, and abating therein the effect of the directly induced electromotive forces which develop in the secondary conductors the neutralizing electromotive forces.

In the accompanying drawings, Figure 1 is a diagram illustrating one embodiment of my invention; Fig. 2 is a front elevation of a transformer adapted for use in the system, and Fig. 3 is a side elevation of said transformer.

Similar characters indicate like parts throughout the several figures of the drawings.

Referring to Fig. 1, a grounded power conductor l, for high potential, low frequency alternating current, is shown extending in proximity and substantially parallel to a number of conductors L^a, L^b, which it is desired to employ for telephonic and telegraphic communication. It may be assumed that the conductors L^a, L^b, are practically equidistant from l. In the present instance the conductors are arranged in twisted pairs, and are therefore adapted for metallic telephone circuits, but they may also be used independently of their application to telephone purposes or simultaneously therewith for grounded telegraph circuits, in the latter case either singly or in pairs by the wellknown composite or simplex methods. The current traversing the power conductor will induce in the signaling lines electromotive forces, tending to produce the disturbing currents and discharges previously mentioned.

In carrying out my invention I first, in the manner already outlined, divide the lines into two groups a and b, the conductors therein being designated as L^a L^b, respectively. I have shown three times as many conductors in the group b as in a with the former distributed upon opposite sides of the last-named group. In practice the distance of each pair of conductors in both groups from the disturbing conductor would be substantially the same, all the signaling conductors, for example, being contained in a cable. With all the conductors of both groups there is associated one or more induction coils or transformers T, of which three are here illustrated. Each transformer, instead of having a single low resistance primary winding, as has previously been the case in induction neutralizing systems of this character, is provided with a double primary winding t for each line in group a, so that each of the conductors L^a of a line pair is connected to one of the two conductors in a primary pair. Each transformer has a plurality of secondary windings t^2, also arranged in pairs, there being at least one of these for each line pair in the group b. Thus, it will be seen that each of the line conductors of both groups have their circuits continued through the transformers independently of the associated conductors.

For the sake of simplicity, the transformers in Fig. 1 of the drawings are shown without cores and with the windings separated from one another. A more correct representation of a transformer adapted for use in the present system appears in Figs. 2 and 3. A rectangular core t^3, built up of laminæ of soft iron, has arranged side by side upon its opposite longer portions the desired number of primary and secondary windings or coils t and t^2, these being as far as possible symmetrically distributed, with one of the primaries alternating with a plurality of the secondaries. With one exception these coils may be identical in construction, they each having preferably three hundred and fifty turns of paired winding of number twenty insulated copper wire, each conductor with a resistance of about five and seventy-five one hundredths ohms. The two conductors may be wound in parallel and transposed at the end of each layer. The primary windings differ from the secondary in being provided with taps t^4, by the use of which the number of turns may be decreased by approximately ten per cent. to secure the proper ratio of transformation.

At points beyond the ends of the power conductor l the line conductors L^a are joined to ground or some other common return at G, G, through connections which are freely permissive to currents induced through the influence of the conductor l, but which are less readily traversed by or are entirely impassable to signaling currents. For this purpose I have shown a conductor 10 extending to ground from each conductor L^a and including in series a condenser C and a retardation coil I. The values of the capacity and inductance are preferably such that the ground connections are resonant for the particular frequency of the parasitic currents and consequently offer thereto a minimum impedance. To low frequency telegraphic impulses and to high frequency telephonic voice currents, they present so great an impedance as to be practically exclusive, and are to a considerable degree so for currents used in generator ringing. To the steady current employed in common battery telephone signaling, these ground connections are rendered entirely opaque by the presence of the condensers. They also prevent the circulation in the primaries of such earth currents as come from direct current trolley systems, and which, by magnetizing the cores of the transformers, would reduce their efficiency.

The operation of the system is as follows: The passage of the disturbing current through the conductor l will induce in each of the signaling conductors L^a and L^b substantially equal electromotive forces. In the primary group a, this electromotive force will cause a flow of current through the circuit furnished by the conductors L^a in parallel, the resonant connections and the common return, which current, traversing the primary windings t of the transformers, generates an electromotive force in each of the secondary windings t^2. The secondary windings are so related to the primaries and so connected to the conductors L^b, that the transformer electromotive force of each secondary conductor opposes that directly induced by the power conductor. Then by supplying each secondary coil with a greater number of turns than its primary to provide for losses in the primary conductors and in transformation, this secondary electromotive force may be made practically to nullify the disturbing electromotive force. Complete compensation cannot be obtained by such a transformer, because of the differences in wave form and phase between the directly induced and secondary electromotive forces in the conductors L^b caused by characteristics of the transformer. This effect, however, may be minimized by the use of an efficient transformer and by keeping down the resistance of the primary circuit, the latter condition being obtained by the multiplying together of the line conductors L^a, which are continued by the plural primaries. Thus, the conductors L^b will be adapted for effective use as both metallic and grounded circuits for telephony and telegraphy between stations A and B, shown upon two of the lines, since the unneutralized parasitic electromotive force and the resulting current are small.

The primary circuits by my invention are also made effective as lines of communication, since telegraph, telephone and other signaling currents are excluded from the ground connections 10, as has been previously pointed out, and may separately traverse the conductors L^a, including the transformer primaries, used either singly as grounded circuits or in pairs as metallic circuits between stations A^2 and B^2. Moreover, the effect upon these signaling circuits of the electromotive force which produces the primary neutralizing current is guarded against. If this were equal to the inductively impressed electromotive force it might, under some conditions of circuit and exposure, be so great as to lead to disruptive discharges, as has been described. But the transformers, by the self induction of their primaries will generate a counter electromotive force opposing the impressed electromotive force and approaching it in magnitude, the difference being the voltage necessary to send the transformer magnetizing current through the primary circuit. As the transformers are designed to operate efficiently and as the resistance of the primary circuit is comparatively small, the resultant electromotive force will be too low to be detrimental.

The number of transformers used depends upon the length of the groups of lines to be protected and the magnitude of the electromotive force induced since each of said transformers will carry its proportionate part of the total voltage and to distribute this among a plurality of transformers increases the factor of safety in case of accident.

In describing the operation of the system I have referred only to the ground connections 10 from the conductors of the primary group *a*, which are beyond the extremities of the disturbing conductor, but it will be apparent that a similar ground might be applied between any two of the transformers and such a one has been indicated at 11. This additional ground connection constitutes a further factor of safety, since, if one of the terminal connections should become in any way opened, partial neutralization would still be secured by the transformers between remaining ground connections.

What I claim is:

1. The combination with signaling conductors arranged in groups each comprising a plurality of conductors, of an induction coil having primary and secondary windings included in different groups and continuing the circuit of each conductor independently of the associated conductors.

2. A signaling system comprising groups of conductors subjected to inductive disturbance from an external source, an induction coil having a plurality of both primary and secondary windings which are respectively included in different conductor groups, a common return conductor, and electrical connection between the primary conductors and return conductor, said connections tending to exclude signaling currents.

3. In a system for nullifying inductive disturbances, the combination with electrical conductors, of an induction coil having primary and secondary windings connected to separate groups of conductors, means for preserving the electrical continuity of each conductor through the induction coil independently of its associated conductors, a common return conductor, and a connection to the common return from each of the conductors united to the primary windings, said connections being resonant for induced disturbing currents.

4. The combination with signaling conductors arranged in groups each comprising a plurality of conductors, of an induction coil having primary and secondary windings included in different groups and continuing the circuit of each conductor independently of the associated conductors, and ground connections from each of the conductors united to the primary windings, said connections being resonant for currents of a particular frequency.

5. An electrical system comprising two groups of conductors, a transformer having primary and secondary windings separately connected in the respective groups, ground connections from the primary conductors, and a condenser and retardation coil included in each ground connection.

6. An electrical signaling system subject to the effects of induction and comprising two groups of conductors, a common return conductor, a transformer having a plurality of primary windings included separately in the circuits of the conductors of one group and secondary windings united to the other group, said transformer being adapted to generate electromotive forces opposing those

induced in the signaling conductors, and connections between the conductors of the primary group and the common return conductor, said connections offering a low impedance to the induced currents and a relatively high impedance to signaling currents.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses, this 24th day of April 1908.

JOHN A. BARRETT.

Witnesses:
ROBERT FOSTER JANES,
SYLVANUS H. COBB.