(Model.)

O. LUGO.

Telegraph Circuit.

No. 240,599. Patented April 26, 1881.

Fig 1.

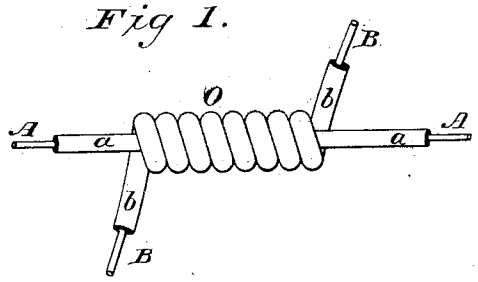


Fig 2.

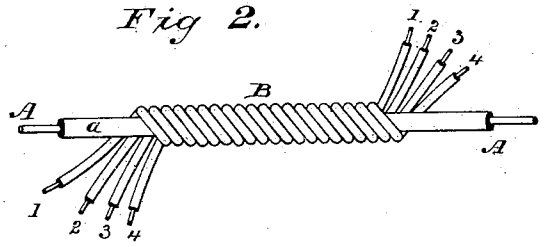


Fig 3.

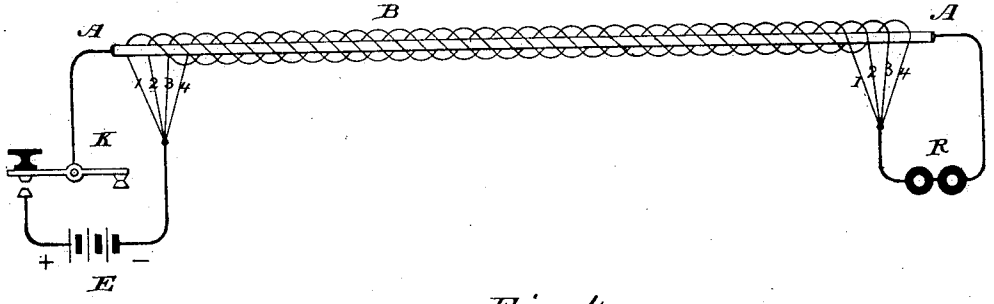
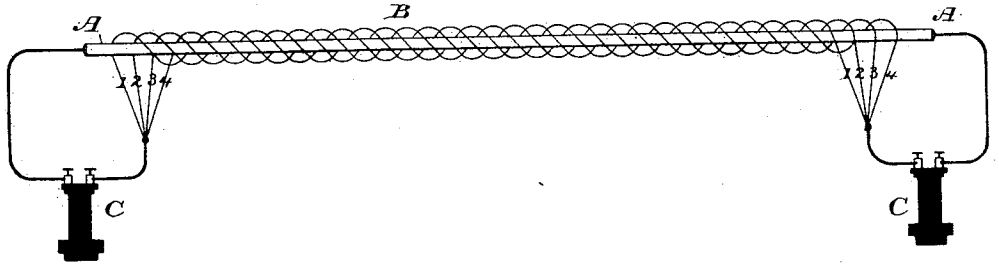


Fig. 4.



WITNESSES

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TELEGRAPH-CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 240,599, dated April 26, 1881.

Application filed February 19, 1881. (Model.)

To all whom it may concern:

Be it known that I, ORAZIO LUGO, a citizen of the United States, residing in the city, county, and State of New York, have invented certain new and useful Improvements in Telegraph-Circuits, of which the following is a specification.

My invention relates to electric circuits for telegraphic and telephonic transmission. Its object is to prevent induction, which end I attain by transmitting the signals through a circuit constituting a solenoid.

The subject-matter claimed is specifically designated in the claim at the end of this specfication.

Telephonic or telegraphic circuits, as is well known, consist, in part, of a conductor of electricity extending from one station to the other, and insulated from all surrounding conducting bodies, including the earth, the circuit being completed either through the earth or through a return-conductor, which may or may not be insulated from the earth, but must be insulated from the first-mentioned conductor, which forms a part of the same circuit. In overland lines the conductors are usually suspended at a considerable height above the ground, and are insulated therefrom and from the various surrounding objects by means of the intervening air, which is an almost absolute non-conductor of electricity. The conductors are insulated from their supports by means of glass or other suitable non-conductor. Subterranean or submarine conductors are insulated by enveloping them in one or more coatings of non-conducting material, usually gutta-percha or paraffine inclosed in a lead or iron pipe or armor.

When a pulsation of electricity is transmitted through a conductor insulated in the manner above described a peculiar phenomenon, termed "electrostatic induction," takes place, which is the inevitable accompaniment of the beginning or ending, the increase or decrease, of the electric current.

Any conductor through which electric currents flow is necessarily partially or wholly surrounded by other conductors, in which induced currents are thus generated. If the whole or a considerable portion of a circuit of conductors of small electrical resistance is very near to a conductor which is traversed by a working-current, and is so situated with reference thereto that the induction tends to occur throughout in one direction, the induced current will be very considerable, and its reaction upon the working-current will also be proportionately great. The effect of this reaction is to diminish, for the time being, the strength of the working-current. If, on the other hand, the circuit in which the induced current flows is situated at a considerable distance from the conductor traversed by the working-current, or if it is only exposed to inductive action for a small portion of its length, or is so situated that the induced current tends to flow in opposite directions in different portions of the circuit, then the induced current will be small and its reaction upon the working-current will also be small. These well-known effects of inductive action constitute very serious obstructions to the efficient transmission of telegraphic or telephonic signals, especially in circuits of considerable length. For example, when a conductor is placed within an insulating-coating, and is laid under ground or under water, the surrounding earth or water constitutes a conductor in which an inductive action is set up, which in turn reacts upon the original current and renders the signals indistinct or confused, the general tendency being to prolong all signals and to obliterate the intervals between successive signals. When two or more such insulated conductors are inclosed within a single conduit, or otherwise placed parallel and in close proximity to each other, the inductive action of the current in each conductor tends to induce correlative currents simultaneously in all the other parallel conductors, and thus interfere with the correct transmission of signals through them. When the electric telephone is used as a medium of communication this effect becomes especially troublesome, for the reason that communications transmitted through any one of the groups of conductors may distinctly be heard in an instrument attached to any one of the other conductors.

Various attempts heretofore have been made to obviate this difficulty, one of which attempts consisted in using two insulated conductors parallel to each other, one for the direct and

the other for the return conductor of the circuit, this organization being based upon the theory that the inductive action of one conductor would be counteracted by equal and opposite action of like character in the other conductor. Although the effects of inductive action are somewhat diminished under this arrangement, they are by no means effectually eliminated, inasmuch as two parallel conductors cannot be so arranged in practice that each can be situated at precisely the same mean distance from all neighboring conductors, from which it results that the inductive action in one portion of a conductor cannot accurately be compensated by the opposite effect in another portion of the other conductor.

My invention is based upon the discovery that if one portion of a circuit be surrounded by the other helically, one portion passing through the mathematical axis of the other, and being properly insulated therefrom, thus forming a solenoid, and either portion be used for the direct, and the other portion for the return conductor of a telegraphic or telephonic circuit of any length, induced, derived, or magnetizing currents will be entirely prevented.

In the accompanying drawings, Figure 1 represents the two portions of a telegraphic or telephonic circuit organized in accordance with the principles of my invention. Fig. 2 shows a modification of the same, which is more suitable for practical use. Fig. 3 is a theoretical diagram, illustrating the application of my invention to a telegraphic circuit; and Fig. 4 in like manner represents its application to a telephonic circuit.

Two metallic conductors, A B, are shown in Fig. 1 as enveloped in the ordinary manner in insulating-coatings *a b* of suitable material, the insulated conductor B being wound helically and as closely as possible around the conductor A, as shown at O. When the ends of the conductors are united they form a solenoid.

I make use of the double conductor constructed, as above described, of any desired length for a telegraphic or telephonic circuit.

It will be evident, upon inspection, that the mean distance of the conductors A B from each other will be the same throughout the entire circuit; and it will also be observed that the mean distance of the conductors from all surrounding objects, of whatsoever nature and of whatsoever actual distance therefrom, will be precisely the same. It follows, therefore, that as the current in traversing the circuit necessarily flows helically in a given direction through one conductor, and directly in the opposite direction from the other conductor, the inductive effect of the current in each conductor, while of opposite character, will be precisely equal in amount.

It is obvious that under the organization hereinbefore described the length of the helical conductor necessarily greatly exceeds that of the other. Consequenty, where of equal conductivity per unit of length, the total resistance of the helical conductor would necessarily be much greater than that of the direct one. Even under these conditions my invention will be operative and induction will be prevented; but I prefer to have the two conductors of substantially equal resistance.

The resistance of the two conductors could obviously be modified by making the helical one of much larger wire than the other; but such a mode of construction is obviously objectionable for mechanical reasons. I obviate this objection by constructing my improved conductor in the manner shown in Fig. 2, which represents the direct conductor A as enveloped in a compound helix consisting of several parallel conductors, 1 2 3 4, which number I have found to be a convenient one in practice, which conductors are of such thickness and electrical conductivity as to render their joint resistance per unit of conductivity, measured on the direct conductor, approximately the same as that of that conductor itself.

Fig. 3 represents an organization of telegraph apparatus preferred by me, which figure shows a battery, E, a transmitting-key, K, a direct axial or central conductor, A, connecting the key with the receiving-instrument R, and four helical conductors, 1 2 3 4, connected in multiple arc with the battery and receiver respectively. This organization of apparatus constitutes what would be called by analogy in other forms of telegraphy a "metallic circuit," either open or closed, according to the normal position of the transmitting-key.

It is obvious that in apparatus thus organized electric currents or pulsations transmitted through one conductor will return through the other, and that the inductive influence of the two sets of conductors, both upon each other and upon all surrounding objects, will be equal and opposite. It follows, therefore, that any inductive effects, of whatever nature, produced in or by the direct conductor, will be neutralized by similar effects produced in the return-conductor.

Fig. 4 illustrates a circuit equipped with speaking-telephones C C, arranged upon the same principles as that hereinbefore described. The telephones act both as receivers and transmitters, the circuit necessarily passing through them.

Any required number of independent circuits of conductors, organized as above described, may lie parallel and close together within a single conduit or pipe, and each conductor will be absolutely protected against the effects of induction, both in itself and in the neighboring conductors, whatever their number or relative position. I am thus enabled to employ one circuit to convey a portion of the current generated by a dyamo-electric machine, and employed to transmit power, or to supply a series of electric-lamps, and to use another circuit for ordinary commercial telegraphy under either the Morse, the duplex, the quadruplex, or the automatic system of transmission, while still another cir-

cuit may be employed for oral transmission by means of speaking-telephones, and any number of such circuits may be inclosed in a single casing without in the slightest degree interfering with each other.

I do not claim herein a solenoid, the helix of which is of substantially equal resistance with the axial conductor per unit of length of the latter, or a series of parallel single conductors constituting a helix, and united in multiple arc with the direct conductor, or the combination, with solenoids so constructed, of signaling apparatus, as these devices constitute the subject-matter of an application, of which this is a division, the claim herein being for a solenoid, whether its branches are of equal or unequal resistance.

I claim as of my own invention—

The electric telegraphic or telephonic conductor herein set forth, constituting a solenoid.

In testimony whereof I have hereunto subscribed my name this 19th day of February, A. D. 1881.

ORAZIO LUGO.

Witnesses:
W. D. BALDWIN,
WM. J. PEYTON.