

Oct. 23, 1928.

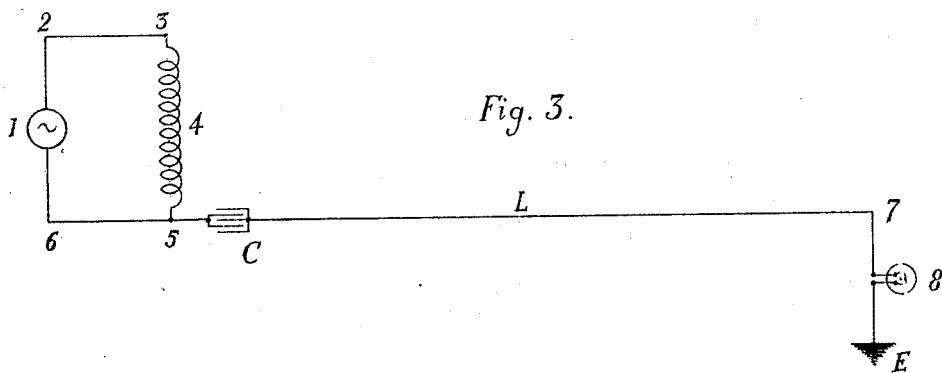
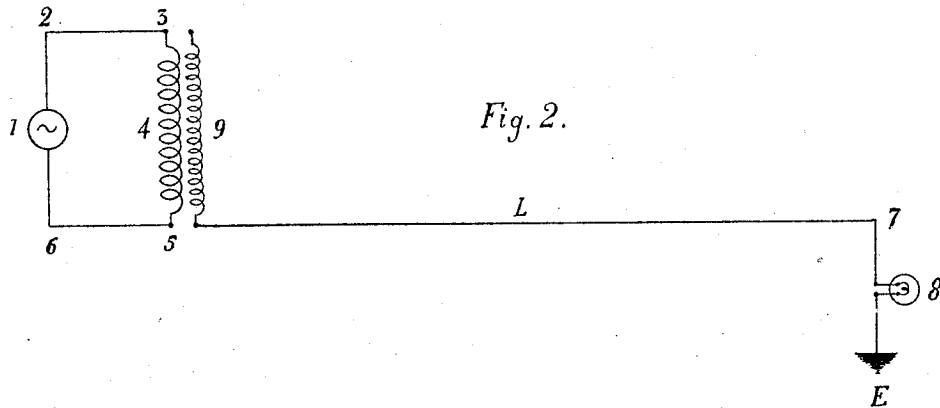
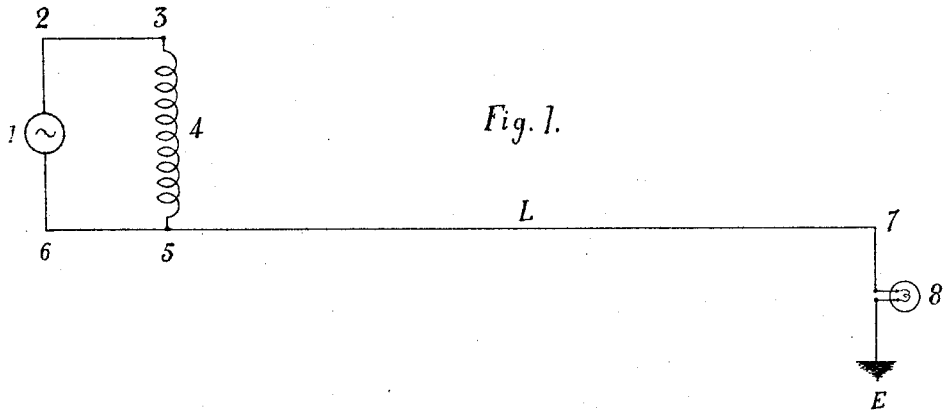
1,688,346

G. MUSSO

SYSTEM OF ELECTRICAL TRANSMISSION

Filed Nov. 17, 1922

2 Sheets-Sheet 1



WITNESSES

Passant Tetroprobs
James M. ...

INVENTOR.

BY *Giuseppe ...*
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Oct. 23, 1928.

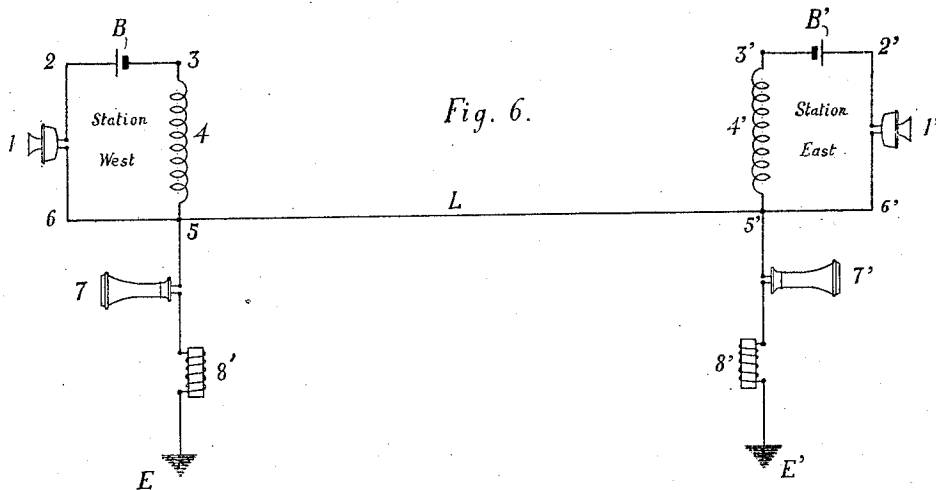
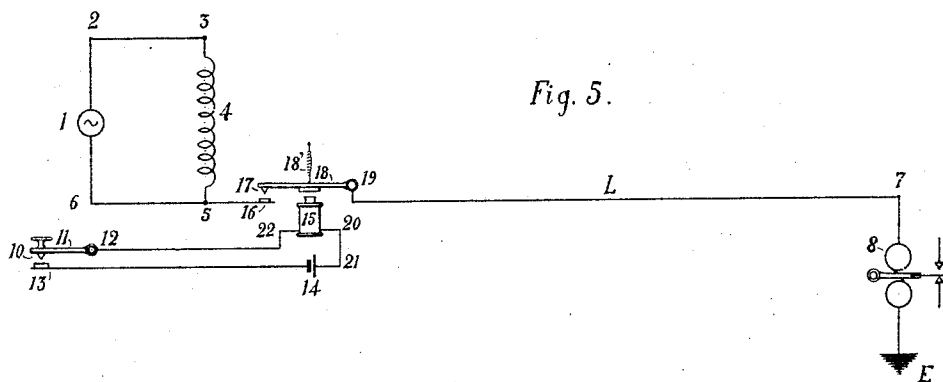
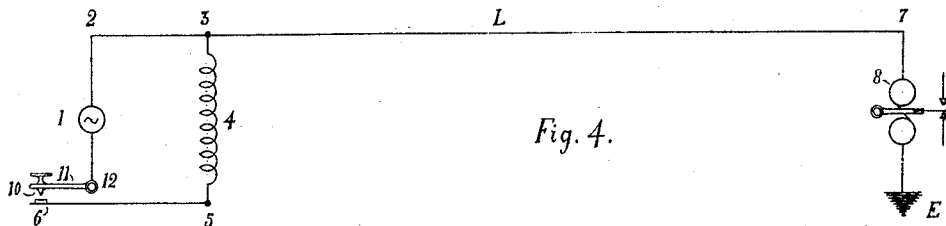
1,688,346

G. MUSSO

SYSTEM OF ELECTRICAL TRANSMISSION

Filed Nov. 17, 1922

2 Sheets-Sheet 2



WITNESSES

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UNITED STATES PATENT OFFICE.

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SYSTEM OF ELECTRICAL TRANSMISSION.

Application filed November 17, 1922. Serial No. 601,526.

In systems of this type, a local transmitting circuit, including suitable transmitting apparatus, is connected through the line or cable to the receiving circuit and apparatus associated therewith at the opposite end of the line. These local circuits are usually connected to earth, or "grounded" and the receiving end of the line is also "grounded", so that the earth forms a part of the return circuit, with the line and connected apparatus the other part of the circuit. If the earth connection of the external circuit or line at the transmitting end is a perfect one, the standard transmission results, i. e., a circulating and condensive transmission, which is subject to the impedance of the line. I have found that if the transmitting end of the line is not grounded, or if the connection to the earth is an imperfect one, I can then obtain, in addition to a standard transmission impulse of a certain value, a separate or additional transmission impulse due to that portion of electric energy which has not succeeded in overcoming the gap or obstruction to earth and was, consequently, repelled or reflected back on the line, from the local circuit, and thereby assumed a new form having distinctive and different characteristics. This form, according to my view, is a non-circulating, oscillating potential energy constituted of free waves, or transverse waves, which propagate to the distant end of the line or cable in search of a suitable way for discharging to earth. I have found that such a form of energy is not affected, in the usual way, by the impedance of the line.

I have found that this form of energy can be produced or impressed on the transmission line, available for transmitting electrical energy over, or through, lines of high impedance, by arranging suitable connections between the various elements, several of which I have illustrated in the accompanying drawings, diagrammatically, through a direct or indirect coupling, permanently or intermittently effected, of an external or main transmission line to a local or "home" circuit, so as to make the external line the seat of a transmission impulse in the form of an oscillating energy or potential, capable of varying rhythmically with the electric impulses generated in the local circuit, consid-

ered as a generating circuit, but preventing the circulating charging currents of the local circuit from passing, in their original form, to the external transmission line, by avoiding any direct ground connection at this end of the transmission line, and causing electric energy to be available, through these impressed potential impulses, at any distant point of the transmission line, by providing a direct ground connection at such point or receiving end of the transmission line, the resulting discharge to ground of the oscillating energy operating the receiving apparatus.

One direct coupling is exemplified in Fig. 1, by the metallic connection, at 5, of an external line L to a home circuit 1, 2, 3, 4, 5, 6.

One indirect coupling is represented in Fig. 2, by a magnetic or inductive connection between the external line L and the home circuit 1, 2, 3, 4, 5, 6. Here the connection is effected by means of a transformer, of which the primary 4 forms part of the home circuit, while its secondary 9 belongs to the external line L.

Still another example of indirect coupling is shown in Fig. 3, by the non-metallic connection of the external line L to the home circuit 1, 2, 3, 4, 5, 6. Here the connection is established through the capacity C.

All couplings represented in Figs. 1, 2, 3, 4 and 6, I consider as permanent couplings, while I regard the coupling shown in Fig. 5 as an intermittent coupling. In Fig. 5, the coupling of the external circuit L with the home circuit 1, 2, 3, 4, 5, 6, occurs every time the lever 18, being attracted by the magnet 15, closes the contact 16, 17, as it will be presently explained.

Referring to Fig. 1, 1 indicates a source of periodic electromotive force; 4 an auto-transformer; 8 is a conventional representation of any suitable apparatus requiring a supply of electric energy; E a connection with the earth.

In Fig. 2, 1 represents a source of periodic electromotive force; 4 and 9 the primary and the secondary, respectively, of a transformer; 8 is a conventional representation of any suitable apparatus requiring a supply of electric energy for its operation; E a connection with the earth.

In Fig. 3, 1 indicates a source of periodic electromotive force; 4 an autotransformer; 8 is a conventional representation of any suitable apparatus requiring a supply of electric energy for its operation; E a connection with the earth.

Fig. 4 shows a simplified telegraph circuit, consisting of the combination of a home circuit 1, 2, 3, 4, 5, 6, 10, 12, and of an external line L permanently connected at 3. The home circuit contains a telegraph transmitting device 11, 6; an inductance 4 and a source of electromotive force 1, preferably, periodic. The external line includes a telegraph receiver or relay 8, connected between the line L at 7 and the earth at E.

Fig. 5 represents a simplified telegraph circuit, consisting of the combination of a home circuit 1, 2, 3, 4, 5, 6, and of an external line L, made susceptible of being rapidly coupled or separated at will through the contacts 16 and 17, by the operation of the transmitting device, which will be presently described. The home circuit contains a source of electromotive force 1, preferably periodic, and it may also include an autotransformer 4. The external line contains the contact lever 18 at the transmitting end, and a receiving device 8 inserted between the line L at 7 and the earth at E, at the receiving end. An auxiliary local circuit 10, 12, 22, 15, 20, 21, 14, 13, includes an electromagnet 15, a battery 14 and a transmitting device or telegraph key 11, pivoted at 12. By depressing the key 11, the contact 10, 13 is closed, the magnet 15 energized and the contact lever 18 attracted, causing the contact 17, 16 to be established, and, consequently, the line L to receive charges of potentials, corresponding to the variations of electromotive force taking place, at the time, in the home circuit 1, 2, 3, 4, 5, 6. 18' is a spring intended to keep the contact 16, 17 normally open.

Fig. 6 suggests a telephone connection suitable for a two-way conversation. Station west and station east are represented as symmetrical. 1, 1' are telephone transmitters; B, B' batteries; 4, 4' inductances; 7, 7' telephone receivers; 8', 8' reactors, serving partly as choke coils to the outgoing waves, and, partly, as intensifiers in favor of the incoming waves; E, E' are connections to the surrounding medium, or earth.

In order to attain the desired conditions, it is not sufficient to merely interpose resistances between the local circuit and earth. While the points having one polarity, at 5 and 5', Fig. 6, are connected to earth, the points having opposite polarity, 3 and 3', should preferably be brought far from the surface of the earth, or any surrounding material medium connected with the earth, and the greater the imperfection or possibility of direct grounding, the purer is the resulting transmission. If points 3 and 3' are situated

in proximity to the earth, comparatively little effort will be required for the potential charge to become neutralized or extinguished, but if this be made difficult, through elevation in space of all the elements constituting the local circuit, then the insulated, or isolated, polarity charge, not being able to reach its opposite polarity charge and be extinguished, will be obliged, or caused, to oscillate. In other words, each succeeding impulse, which in a closed circuit would cease to exist instantaneously, is forced to live longer in this open circuit, giving rise to actual oscillations. Or, putting the statement in a slightly different form each succeeding impulse is converted into a series of damped waves, which, in their propagation over the transmission line, behave quite differently from the ordinary circulating, closed circuit, impulses, and this is the energy utilized and primarily responsible for my system of transmission.

It is now evident, by an examination of any of the above explained diagrams, that the external line L represents neither a "metallic circuit" nor a "grounded circuit", in the meaning these expressions are commonly accepted. In fact, it prevents, in our case, all possibility for circulating charging currents to pass from one home circuit to its connecting external line, for want of a path wherein to circulate. This external line can only receive rhythmic potential charges of oscillating energy, corresponding to the variations of energy impulses or electromotive force taking place in its particular home circuit, in accordance with the transmitting device therein employed; and such potential charges can be converted into useful energy by properly neutralizing them or discharging them to the surrounding medium at any distant point of the line.

Again, if, by referring to Fig. 6, we consider the transmission from one station (station west, for instance), it appears evident that the electric charges passing to the line L have the same sign or polarity as those passing to the wire leading to the local earth E, owing to their being derived from a common point 5, so that there cannot arise in L any manifestation of capacity to earth, as it would be the case with circulating charging currents.

As far as the earth connection is concerned, I have found that, in order to obtain satisfactory results, it is not always indispensable to use a so-called "good ground". It is indeed sufficient, and, in many cases, preferable, to employ a quite imperfect connection with the surrounding medium.

I claim:

1. The method of transmitting electric energy by impressing electric impulses on an external circuit having different characteristics from those of the initial impulses, which consists in converting a substantial portion of

the energy of a periodic electromotive force circulating in a local circuit at one end of a transmission line into transmission impulses in the form of non-circulating potential energy impressed on the transmission line preventing the circulating charging current of the initial impulse in said local circuit passing on said transmission line, and discharging said impulses to earth at the opposite end of the transmission line, utilizing the discharge of said impressed potential impulses through receiving apparatus.

2. The method of transmitting electric energy by impressing electric impulses on an external circuit having different characteristics from those of the initial impulses, which consists in the establishing in a local circuit circulating periodic impulses, impressing said impulses on the transmission line in the form of oscillating impulses preventing the circulating charging current of the initial impulse in said local circuit passing on said transmission line, and discharging said oscillating impulses to the earth at the receiving end of the transmission line, utilizing the discharge of said impressed potential impulses through receiving apparatus.

3. The method of transmitting electric energy by impressing electric impulses on an external circuit having different characteristics from those of the initial impulses, which consists in establishing in a local circuit circulating periodic impulses, preventing a substantial portion of the energy of said impulses from passing to earth but causing the same to be reflected on the transmission line in the form of oscillating impulses preventing the circulating charging current of the initial impulse in said local circuit passing on said transmission line, and discharging said oscillating impulses to the earth at the receiving end of the transmission line, utilizing the discharge of said impressed potential impulses through receiving apparatus.

4. In a system for transmitting electric energy, means for impressing electric impulses on an external circuit and means adapted to prevent circulating charging current of the initial impulses in a local circuit passing to said external circuit, said means comprising a local circuit including means adapted to set up circulating impulses in this local circuit, said local circuit not being grounded or directly connected to earth, a transmission line coupled at one end to said local circuit and directly connected to earth at its opposite end through suitable receiving apparatus, and receiving apparatus adapted to be operated by the discharge from said transmission line to earth.

5. In a system for transmitting electric energy, means for impressing electric impulses on an external circuit and means adapted to prevent circulating charging current of the

initial impulses in a local circuit passing to said external circuit, said means comprising a local circuit including a source of periodic electromotive force and a transmitting device adapted to set up circulating impulses in this local circuit, said local circuit not being grounded or directly connected to earth, a transmission line coupled at one end to said local circuit and directly connected to earth at its opposite end through suitable receiving apparatus, and receiving apparatus adapted to be operated by the discharge from said transmission line to earth.

6. In a system for transmitting electric energy, means for impressing electric impulses on an external circuit and means adapted to prevent circulating charging current of the initial impulses in a local circuit passing to said external circuit, said means comprising a local circuit including a source of periodic electromotive force, an inductance and a transmitting device adapted to set up circulating impulses in this local circuit, none of the said elements of the local circuit being grounded or directly connected to earth, a transmission line coupled at one end with one terminal of said inductance and directly connected to earth at its opposite end through suitable receiving apparatus, and receiving apparatus adapted to be operated by the discharge from said transmission line to earth.

7. In a system for transmitting electric energy, means for impressing electric impulses on an external circuit and means adapted to prevent circulating charging current of the initial impulses in a local circuit passing to said external circuit, said means comprising a local circuit including a source of periodic electromotive force, a transformer and a transmitting device, the primary of said transformer being in series therewith, adapted to set up circulating impulses in said local circuit, neither the local circuit or transformer secondary being grounded or directly connected to earth, a transmission line connected at one end with one terminal of the secondary of said transformer and directly connected to earth at its opposite end through suitable receiving apparatus, and receiving apparatus adapted to be operated by the discharge from said transmission line to earth.

8. In a system for transmitting electric energy, means for impressing electric impulses on an external circuit and means adapted to prevent circulating charging current of the initial impulses in a local circuit passing to said external circuit, said means comprising a transmission line connecting two distant local circuits, each of said local circuits comprising a source of electromotive force, an inductance and a transmitting device, one corresponding terminal of each of said inductances being connected to the opposite

ends, respectively, of the transmission line and to earth through a receiving device and an impedance adapted to prevent the passage of the outgoing transmission impulses from the local circuit at that end of the transmission line which is transmitting while permitting the passage directly to earth, through the receiving device, of the incoming transmission impulses received over the transmission line from the local circuit at the opposite end thereof. 10

Signed at Habana, Republic of Cuba, this 31st day of Oct., A. D. 1922.

GIUSEPPE MUSSO.