

J. C. LEE & E. H. COLPITTS.

LOADED ELECTRIC CIRCUIT.

(Application filed Nov. 30, 1901.)

(No. Model.)

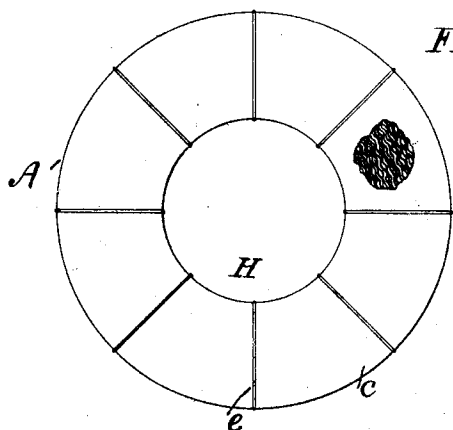


Fig. 1.

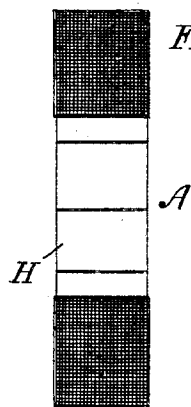


Fig. 2.

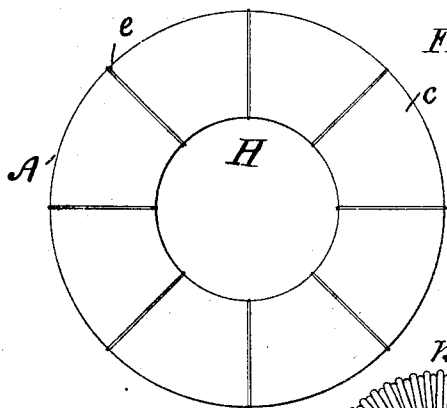


Fig. 3.

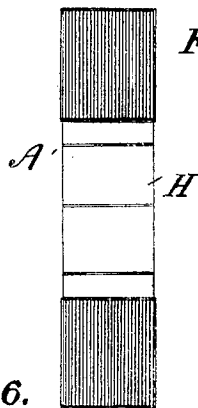


Fig. 4.

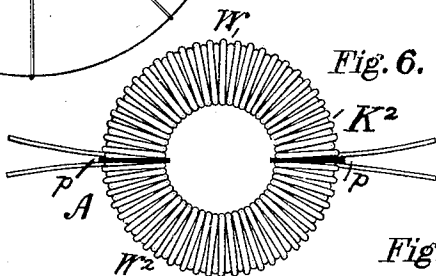


Fig. 6.

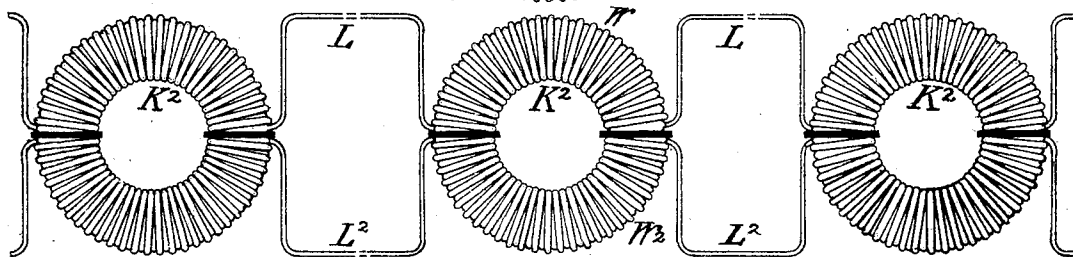
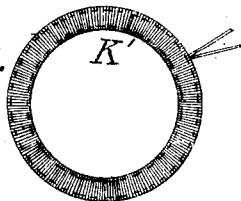


Fig. 7.

WITNESSES:

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Fig. 5.



INVENTORS

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UNITED STATES PATENT OFFICE.

JOHN C. LEE, OF BROOKLINE, AND EDWIN H. COLPITTS, OF BOSTON, MASSACHUSETTS, ASSIGNORS TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

LOADED ELECTRIC CIRCUIT.

SPECIFICATION forming part of Letters Patent No. 705,936, dated July 29, 1902.

Application filed November 30, 1901. Serial No. 84,200. (No model.)

To all whom it may concern:

Be it known that we, JOHN C. LEE, residing at Brookline, in the county of Norfolk, and EDWIN H. COLPITTS, residing at Boston, in the county of Suffolk, State of Massachusetts, have invented certain Improvements in Loaded Electric Circuits, of which the following is a specification.

It is now well known that the efficiency of electrical circuits for the transmission of energy by varying currents, especially telephone-circuits, may be increased by inserting therein at proper intervals and in series inductance-coils of low resistance and high inductance. The circuits so equipped are known as "loaded lines," and inductance-coils thus associated with them are sometimes termed "loading-coils." To obtain the required inductance with a smaller number of turns of the electric winding than otherwise would be necessary, and thus to keep the coil small in size and of low resistance, loading-coils have been provided with iron cores; but the employment of iron introduces certain core losses, since though possessing maximum permeability iron is likewise highly conductive, and its conductivity facilitates the generation and development of parasitic or eddy currents at the expense of the working current, which is correspondingly weakened. These losses are of such serious consequence in telephonic circuits by reason of the extremely high periodicity of the telephonic current that in order to sufficiently reduce them it has been found necessary to carry out the division of the iron to the most radical extent and to have each element thereof as thin as possible. Cores for loading-coils have accordingly been made by winding a great number of turns of exceedingly fine wire into the form of a ring of generally circular cross-section, by piling flat rings of very thin sheet-iron one above another, or by coiling a thin iron ribbon in a number of spirally-arranged turns after the manner of the mainspring of a watch, the several convolutions, plates, or spires being in each instance thoroughly insulated from one another. The reduction of iron, whether in sheets, ribbons or wire, to

the thinness and small size demonstrated by experience to be necessary is, however, a slow, difficult, and expensive process, and to perfectly insulate the plates, strips, or wire so reduced is also expensive and difficult.

To improve loading-coils and loaded circuits by providing for the said coils magnetic cores formed of a practical substitute material for finely-divided and insulated iron, which cores, while possessing permeability in a high degree also possess the qualifications of high electrical resistance, and to provide such cores at less cost, are the objects of our invention.

In a separate application for Letters Patent filed by us of even date herewith, Serial No. 84,199, is described a method or process for the production of suitable loading-coil cores of magnetic oxid or of ferroso-ferric oxide (Fe_3O_4) and a non-conducting highly-permeable compact core practically continuous in the direction of magnetization produced by such method. To produce such cores by the said method, thin plates, ribbons, or very small wire of magnetic metal, as iron, are assembled, lapped, or wound into a loosely-built or partly open-work structure corresponding in form and dimensions to the conformation and size of the core desired, and the said structure or core form is then subjected to the roasting action of heat in an atmosphere capable of yielding oxygen to the iron until the said iron is reduced or converted into magnetic oxid. The core thus made is therefore composed of artificial magnetic oxid, and while retaining the form in which it was originally built up or constructed has become dense, continuous, and compact. It possesses, moreover, in a high degree the desired qualifications of permeability and high specific electrical resistance, and in consequence of the latter has no tendency to serve as a circuit for the formation and development of eddy-currents. Our present invention is based on the invention of the said application and contemplates the employment of such a magnetic or ferroso-ferric oxid-core in combination with the electric conductor, helix, or winding of a loading-coil.

It also comprises an electric circuit for transmitting energy by varying currents loaded with ring-shaped inductance-coils connected therein at proper intervals, each said
 5 coil consisting of an electrical winding or windings surrounding or provided with a magnetic core constituted in the form desired of a compact mass of magnetic oxid. The cross-section of the core and its toroidal conformation determine the general character and
 10 shape of the finished inductance-coil, and the electrical winding may be formed either of a continuous helix of insulated copper wire closely covering every part of the core or of
 15 two continuous helices of the said wire holding like magnetic relation to the said core and together covering the same.

In the drawings, Figures 1 and 2 represent, respectively, in plan and central cross-sectional view a loading-coil core prepared by winding crimped iron wire into the conformation desired and then converting the same into ferroso-ferrie oxid. Figs. 3 and 4 are
 20 similar views of a core made by building up thin iron plates and similarly oxidizing the mass. Fig. 5 is a representation of a loading-coil formed by winding a single conductor around a ring-core of magnetic oxid. Fig. 6 represents a loading-coil complete, formed
 25 by winding two insulated conducting-wires over the two halves of such a core. Fig. 7 represents an electrical circuit equipped with inductance-coils according to our invention.

In Figs. 1, 2, 3, and 4, A is the magnetic
 35 core as a whole, which being generally formed as a torus or ring has a hole H through its center. The cross-section of the said ring may be circular, elliptical, or in the form of a parallelogram, as preferred.

In the figures, c represents a covering or wrapping of stiff paper or linen strips, which may be secured by a resinous or asphaltic cement or by cords or ligaments e, which may
 40 pass through the central hole and around the substance of the core, or, if desired, the said fibrous covering may be dispensed with and the said resinous or asphaltic material employed alone. In Fig. 1 a portion of the covering is shown as being broken or torn away
 45 to indicate the original metallic composition of the core, such composition being also indicated for each case by the cross-sectional views Figs. 2 and 4, respectively.

The core, illustrated by Figs. 1 and 2, is
 55 made by converting into a compact mass of magnetic oxid a ring initially prepared by winding crimped wire a of a suitable magnetic metal or alloy, such as iron, to the desired form and size. That illustrated by
 60 Figs. 3 and 4 is prepared by similarly reducing to magnetic oxid a structure prepared by building or piling up thin ring-shaped plates of magnetic metal one upon another. These magnetic oxid cores are dense and
 65 compact in their substance, possess satisfac-

tory permeability, and being of very high resistance or practically devoid of conductivity they oppose the generation and development of eddy-currents without the necessity of employing a specially-associated insulating medium.

W is the copper or electrical conductor, wound closely over the magnetic oxid core A. In Fig. 5 is shown a loading-coil K having
 75 but a single conductor, which is wound over the entire core. In the coil K² of Fig. 6 two electrical windings are provided and are shown as being wound over two equal portions, into which the surface of the core is divided by the partition p. Loading-coils
 80 having compact and solid magnetic oxid cores are connected up in the circuit, to be equipped with them in the same way that any loading-coils are employed and connected. It is of course necessary that in metallic-circuit tele-
 85 phone-lines the inductance-windings associated with one side of the circuit shall balance those connected with the other side. Keeping this requirement in mind, it is evident that the form of coil K² shown in Fig. 6 is
 90 very convenient. Accordingly in Fig. 7 the telephone-circuit B is represented as being provided with the double conductor-coils K², the windings W of the several coils being in series in conductor L, while the windings
 95 W² are similarly connected in conductor L² of the said circuit.

We claim—

1. A loading-coil, consisting of a core of continuous or compact high-resistance material having high permeability, and an electrical winding surrounding the said core, substantially as described.

2. A loading-coil having a properly-formed compact mass of artificial magnetic
 105 oxid for a core, with an electrical winding surrounding the said core, substantially as described.

3. A loading or inductance coil comprising a magnetic core constituted of ferroso-ferrie
 110 oxid formed in a compact mass, and an electrical conductor wound or coiled thereover, substantially as described.

4. An electrical circuit for the transmission of energy by varying currents provided with
 115 inductance-coils serially connected therein at proper intervals, the said coils having highly-permeable and high-resistance cores constituted of dense or closely-compacted magnetic oxid of iron or like magnetic metal
 120 or alloy, substantially as described.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, this 25th day of November, 1901.

JOHN C. LEE.

EDWIN H. COLPITTS.

Witnesses:

THOMAS D. LOCKWOOD,
 GEO. WILLIS PIERCE.