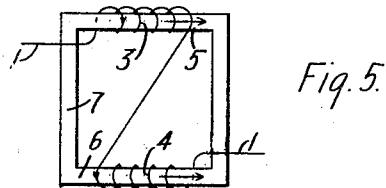
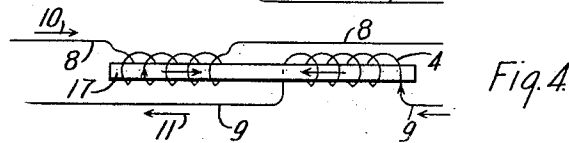
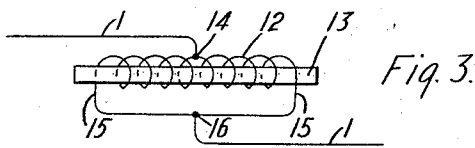
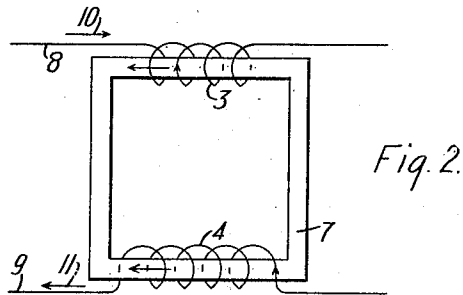
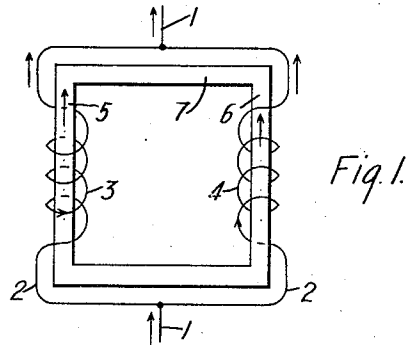


Q. A. BRACKETT.
LIGHTNING ARRESTER.
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1,291,386.

Patented Jan. 14, 1919.



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LIGHTNING-ARRESTER.

1,291,386.

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To all whom it may concern:

Be it known that I, QUINCY A. BRACKETT, a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Lightning-Arresters, of which the following is a specification.

My invention relates to electrical protective devices, and it has special reference to devices inserted in electrical circuits to protect the apparatus associated therewith from high-frequency surges or impulses.

More particularly, my invention relates to lightning arresters of the choke-coil type in which the inductive effects arising therefrom, when subjected to the flow of currents of normal or commercial frequencies are negligible, but, when subjected to the flow of high-frequency currents, such as obtain in lightning disturbances, are considerable and, consequently, effective in precluding the discharge of such current to the electrical apparatus connected in circuit.

It is a common practice to insert ordinary choke coils comprising a relatively small number of turns, in circuit with line conductors in order to protect the electrical apparatus from the effects of high-frequency currents arising on the transmission line. Choke coils of this character reflect a portion of the high-frequency currents back upon the line, permitting portions only of the disturbances to filter through to the electrical apparatus. However, when severe disturbances occur on the transmission lines, a considerable quantity of these high-frequency currents may be permitted to flow through choke coils of the ordinary type to the electrical apparatus. In these instances, the strains arising from the admission of these "filtered" high-frequency currents may be sufficient to puncture the insulation employed in the electrical apparatus.

Heretofore, the inductive effect resulting from such choke coils, which have no magnetizable core members, has been limited to relatively small values, because the impedance offered to the flow of currents of normal or commercial frequencies must be maintained low for obvious reasons. As a result of limiting the number of turns of these ordinary choke coils, they are fre-

quently ineffective in suppressing high-frequency disturbances.

One object of my invention is to provide a lightning arrester of the choke-coil type which will offer very little or negligible impedance to the flow of currents of normal or commercial frequencies but which will offer high impedance to the flow of high-frequency currents, such as obtain in lightning disturbances and the like.

For a better understanding of the nature and scope of my invention, reference may be had to the following description and the accompanying drawing in which Figure 1 is a diagrammatic view of a lightning arrester constructed in accordance with my invention; Fig. 2 is a diagrammatic view of a modified form of the device shown in Fig. 1, and Figs. 3, 4 and 5 are diagrammatic views of modified forms of the devices shown in Figs. 1 and 2.

Referring particularly to Fig. 1, a line conductor 1 is connected in series relationship with a divided circuit 2. The divided circuit 2 comprises a coil 3 and a coil 4 which are connected in parallel relationship with each other and oppositely wound so that oppositely-directed fluxes are generated when currents flow simultaneously through the coils 3 and 4. The coils 3 and 4 are disposed on opposite legs 5 and 6, respectively, of a common magnetizable core member 7 which comprises a closed magnetic circuit.

Each of the coils 3 and 4 comprises a relatively large number of turns and, when energized alone, is of high inductance. However, the said coils are oppositely wound and so disposed on the core member 7 that the fluxes generated by currents of normal frequencies flowing therethrough are oppositely directed. Again, the coils 3 and 4 are composed of the same number of turns and, consequently the value of the resultant magnetic flux flowing through the core member 7, under normal conditions, is substantially zero. Therefore, the inductance offered to the flow of the line currents along the conductor 1 is negligible. However, when high-frequency disturbances of short wave lengths tend to flow along the conductor 1, the impedance offered by the coils 3 and 4 is very great. Therefore, the disturbances are reflected back upon the line, and the

electrical apparatus connected in circuit is afforded ample protection. This action may be explained by the fact that the mutual induction between coils 3 and 4, when normal frequency currents flow therethrough, is very large. Under these circumstances, the iron core 7 closely links the coils 3 and 4 magnetically, since the fluxes generated in the core member 7 do not lag an appreciable time behind the magnetizing forces generated by currents of commercial frequencies. In other words, the hysteretic lag of the magnetic induction of the core member 7 is inappreciable when currents of low frequency flow through coils 3 and 4. However, when high-frequency currents tend to flow through the coils, the hysteretic lag of the core member 7 is very appreciable, and the mutual induction between the coils 3 and 4 is inconsiderable. In these instances, the self inductance of each of the coils 3 and 4 asserts itself and offers a very high impedance to the flow of high frequency currents over the conductor 1.

In Fig. 2, the coils 3 and 4 are inserted in circuit with conductors 8 and 9, respectively, which comprise a power-transmission circuit. For the purpose of illustration, current may be considered as flowing over the conductor 8 in the direction of an arrow 10 and simultaneously over the conductor 9 in the direction of an arrow 11. In this instance, current flows through the coils 3 and 4 in opposite directions, and said coils must be so wound and disposed on the core member 7 that the fluxes flowing therethrough may flow in the direction indicated by the arrow. When currents of low frequency, such as obtain in commercial circuits, flow over the transmission conductors 8 and 9, the value of the impedance offered by the coils 3 and 4 is substantially zero, inasmuch as the fluxes generated by the flow of currents through said coils are neutralized. However, when high-frequency currents flow over either one or both of the conductors 8 or 9, the impedances offered by the coils 3 and 4 are considerable, and the high-frequency currents are reflected back upon the line and are precluded from flowing through the electrical apparatus associated with the circuit.

As the action of the device shown in Fig. 2 is similar to the action of the device shown in Fig. 1, further explanation in regard thereto is deemed unnecessary. Of course, it will be understood that a high-frequency disturbance may occur on either one of the conductors 8 and 9 without simultaneously occurring upon the other conductor. Under these circumstances, the impedance offered by the high-inductance coils 3 or 4 will afford ample protection to the electrical apparatus.

The choke coil shown in Fig. 3 comprises

a single winding 12 which embraces an iron core 13. A tap 14 is provided at the midpoint of the coil 12 in order to connect one section of the line conductor 1 thereto, terminals 15 of the coil being connected to a common point 16 for connection to the other section of the conductor 1. When line currents of normal or commercial frequencies flow over the conductor 1, the impedance offered by the choke coil is substantially zero, but, when such high-frequency currents as obtain in lightning disturbances, tend to flow over the line conductor 1, the impedance offered by the choke coil is considerable. It will be noted that the device of Fig. 3 is somewhat similar to the structure shown in Fig. 1, with the exception of the core member 13 which, in Fig. 3, does not provide a closed magnetic circuit.

In Fig. 4, I have shown a modified form of the device shown in Fig. 2. However, I have substituted for the magnetizable member 7 of Fig. 2 a core member 17 which does not form a closed magnetic circuit. The coils 3 and 4 are wound and applied in a manner similar to that shown in Fig. 2. Moreover, they are connected in series circuit with line conductors 8 and 9, respectively, as shown. When line currents of normal or commercial frequencies flow over the conductors 8 and 9, the resultant flux flowing in the core member 17 is substantially zero and, therefore, under normal operating conditions the impedance offered by the choke coil is negligible. When high-frequency currents flow over the transmission line conductors 8 and 9, the impedance offered by the choke coil is very high because of the high hysteretic lag of the core member 17, as explained above. In Fig. 5, the coils 3 and 4 are wound upon the two oppositely-disposed legs 5 and 6 of the magnetizable member 7, as explained in connection with Fig. 1. In this instance, however, the coils 3 and 4 are connected in series relationship with each other and also in series with the line conductor 1. Under normal conditions, the fluxes generated by the low-frequency currents flowing through the coils 3 and 4 are oppositely directed and substantially neutralize each other. When high-frequency currents tend to flow over the line conductor 1, the impedance offered by the coils 3 and 4 is considerable because of the high hysteretic lag of the magnetizable core member 7.

From the foregoing description, it will be seen that it is desirable to make the core member 7 of a material in which the magnetic induction lags appreciably behind the magnetizing force applied thereto. The hysteretic lag thus occasioned is useful in offering high impedance to high-frequency currents flowing through the coils 3 and 4.

On the other hand, the period of this hysteretic lag is of small import when the currents flowing through the coils 3 and 4 are of relatively low frequencies, such as are utilized in commercial power circuits.

While I have shown and described several embodiments of my invention, it will be apparent to those skilled in the art that many modifications may be made without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. A protective device comprising a magnetizable core member forming a closed magnetic circuit of high hysteretic lag and having a plurality of core legs, coils severally embracing the legs of said core member, said coils being oppositely wound and connected in parallel relationship with each other and in series relationship with a line conductor.

2. A protective device comprising a magnetizable core member forming a closed magnetic circuit and being composed of material having a high hysteretic lag, coils embracing the several legs of said core member and being oppositely wound and connected in parallel relationship with each other and in series relationship with a line conductor whereby the coils will magnetically neutralize each other when low-frequency currents flow therethrough but which will act as independent reactive elements when high-frequency currents flow therethrough.

3. The combination with a line conductor subject, at times, to the flow of low-frequency currents and, at other times, to the flow of high-frequency currents, of a frequency-selective inductive device inserted therein, said device comprising a plurality of current-carrying conductors connected in parallel relation and means for closely magnetically coupling said conductors with low-frequency currents and for loosely magnetically coupling said paths with high-frequency currents.

4. The combination with a line conductor subject, at times, to the flow of low-frequency currents and, at other times, to the flow of high-frequency currents, of a frequency-selective inductive device inserted therein, said device comprising a plurality of current-carrying conductors connected in parallel relation and each arranged to carry a portion of the line current, and a magnetic core member inductively interlinking said conductors, the dimensions and magnetic properties of said core member being such that it affords a relatively close coupling between said conductors at low frequency and a relatively loose coupling with high frequency.

5. The combination with a line conductor subject, at times, to the flow of low-frequency currents and, at other times, to the

flow of high-frequency currents, of a frequency-selective inductive device inserted therein, said device comprising a plurality of current-carrying conductors connected in parallel relation and each arranged to carry a portion of the line current, and a magnetic core member inductively linking said conductors, the algebraic sum of the magnetomotive forces developed within said core member by said conductors being substantially zero and the dimensions and magnetic properties of said core member being such that the hysteretic lag therein on high-frequency currents renders the magnetic coupling of said conductors less effective than with low-frequency currents.

6. The combination with a line conductor subject, at times, to the flow of low-frequency currents and, at other times, to the flow of high-frequency currents, of a frequency-selective inductive device inserted therein, said device comprising means for developing a plurality of magnetomotive forces from said line current in a common core member, the algebraic sum of said magnetomotive forces, as combined, being substantially zero and the dimensions and magnetic properties of said core member being such that the coupling action thereof on the seats of magnetomotive force is looser on high-frequency currents than on low-frequency currents.

7. The combination with two electric conductors subject, at times, to the flow of low-frequency currents, and, at times, to the flow of high-frequency currents, the relative directions of current flow between said conductors being the same with both conditions of frequency, of means for magnetically coupling said conductors, the algebraic sum of the magnetomotive forces of said conductors, as combined, being substantially zero and said coupling means affording a closer coupling with low-frequency currents than with high-frequency currents.

8. The combination with two electric conductors subject, at times, to the flow of low-frequency currents, and, at times, to the flow of high-frequency currents, the relative directions of current flow between said conductors being the same with both conditions of frequency, of a core member, and means for developing a magnetomotive force in said core member from the currents of each of said conductors, respectively, the algebraic sum of said magnetomotive forces as combined being substantially zero, and the dimensions and magnetic properties of said core member being such that an appreciably looser coupling is afforded with high-frequency currents than with low-frequency currents.

9. The combination with two electric conductors subject, at times, to the flow of low-frequency currents, and, at times, to the flow

of high-frequency currents, the relative directions of current flow between said conductors being the same with both conditions of frequency, of coils inserted in each of said conductors, respectively, and embracing a common core member, the algebraic sum of the magnetomotive forces of said coils, as combined in said core member, being substantially zero and the material of said

core member having a pronounced hysteretic lag, whereby said coils are more loosely coupled with high-frequency currents than with low-frequency currents. 10

In testimony whereof, I have hereunto subscribed my name this 23rd day of April 15 1915.

QUINCY A. BRACKETT.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."