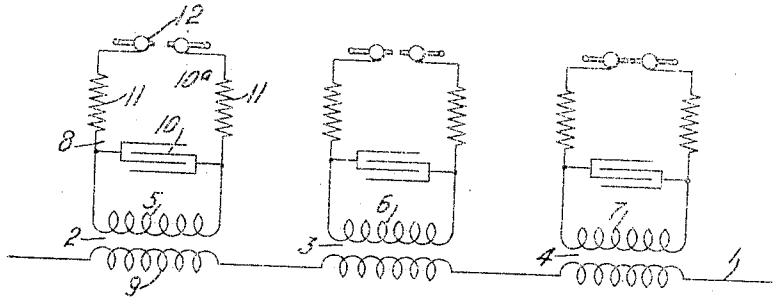
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LIGHTNING ARRESTER.

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1,212,129.

Patented Jan. 9, 1917.



WITNESSES:

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LIGHTNING-ARRESTER.

1,212,129. Specification of Letters Patent. Patented Jan. 9, 1917.

Application filed September 10, 1914. Serial No. 861,142.

To all whom it may concern:

Be it known that I, ALEXANDER CHERNYSHOFF, a subject of the Czar of Russia, and a resident of Swissvale, 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 devices and methods for protecting electrical circuits and apparatus from injury to which they are exposed by reason of strains occasioned by lightning discharges, static, and other disturbances that are accompanied by the flow of high-frequency currents.

My invention relates particularly to lightning arresters which are very effective in operation and which require no ground connections or connections between transmission conductors in order to dissipate rapidly the energy of the disturbance.

It is well known that, when a choke coil is inserted in a circuit, the disturbing waves traveling along the line are reflected back upon the line by the choke coil, thereby protecting the electrical apparatus connected to the line. However, a choke coil is not always effective in case of disturbances of very high frequency and of very high voltage because the entire self induction of the choke coil cannot come into play. In this instance, it is very likely that the disturbance will discharge across the choke coil and pass uninterruptedly to the electrical machinery which it was intended that the choke coil should protect.

Another well known protective device consists of a concentrated capacity or condenser which is connected in proximity to, and in front of, the apparatus to be protected and between the transmission conductors or between a conductor and ground. By means of this arrangement, the major portion of the disturbing wave is reflected back upon the line by the condenser, thereby permitting a small portion only of the disturbing wave to pass through the electrical apparatus.

In each of the above-mentioned protective devices, the disturbing wave is repeatedly reflected back upon the transmission line, and its energy is slowly dissipated by reason of the very low ohmic resistance of the line. While the major portion of each disturbing wave is intermittently reflected back upon the line, a small portion of the disturbance passes through the electrical apparatus, and consequently, repeatedly imposes abnormal stresses thereupon until the energy of the disturbing wave is completely dissipated.

To preclude the continual reflection of the disturbing wave back upon the line, it has been proposed to employ a concentrated inductance, such as a choke coil, and a resistor connected in parallel relation therewith, the combination being connected in series with one of the line conductors. Because of the low frequency of the normal power current, the choke coil offers very little impedance to its flow over the transmission conductor. However, when a high-frequency disturbance occurs upon the line, the choke coil forces the disturbance to flow through the resistor, thereby converting a large portion of its energy into heat. Inasmuch as only a portion of the energy of the disturbance is converted into heat by the resistor and another portion of the disturbing wave is reflected back upon the line, while still another portion is permitted to flow through the apparatus, it will be readily understood that the above arrangement does not insure absolute protection of the electrical apparatus against powerful disturbances.

In order to avoid the aforesaid defects in the lightning arresters described, it has been suggested to employ a combination of elements; namely a concentrated self induction, a concentrated capacity, and an ohmic resistance, all of said elements being simultaneously connected to adjacent points on the transmission conductor. In this combination, the inductive element and the resistor are connected in multiple and inserted in series with the line conductor. One terminal of the capacity element is connected to the transmission conductor immediately adjacent to the inductive element and the resistor, and the other terminal is connected to another transmission line conductor. The inductive element reflects the disturbing wave back upon the line with its normal sign, and the capacity element reflects the disturbing wave back upon the line with a reversed sign. These two individually reflected waves substantially neutralize each

other and, therefore, permit only a small portion of the disturbing wave to pass through the resistor where its energy is dissipated as heat. It will be seen that this protective device has a drawback resulting from the necessity of making an electrical connection between transmission line conductors. In high-voltage installations, this is particularly undesirable because of the difficulty in properly insulating the line conductors from each other.

One object of my invention is to provide a protective device for protecting electrical circuits and the apparatus associated therewith against strains occasioned by the flow of high-frequency currents. Also, by means of my invention, protection may be afforded against currents of extremely wide ranges of frequency.

A further object of my invention is to provide a lightning arrester which does not require periodical inspections and renewals, and which may be easily inserted in the electrical circuit without any additional supporting structure and the usual and unreliable ground connections.

To understand the nature of my invention, reference may be had to the following description and the accompanying drawing which is a diagrammatic view showing a transmission line conductor provided with devices constructed in accordance with my invention.

With a transmission line conductor 1, I have shown a plurality of series transformers 2, 3 and 4, or the equivalent thereof, the primary windings of which are connected in series relationship. The secondary windings 5, 6 and 7 of said transformers are connected in local circuits each of which comprises a capacity element, a resistor and spark gap members.

To illustrate more particularly the composition of the local circuits associated with the secondary windings of the transformers, I will describe a local circuit 8 which comprises the secondary winding 5 of the transformer 2. The primary winding 9 of the transformer 2 is inductively related to the secondary winding 5 in any suitable manner, but preferably through the intermediary of an air core. It will be understood, however, that an iron core provided with a suitable air gap may be used. It is important that the primary winding 9 shall offer very little impedance to the flow of normal power currents of substantially low frequencies. However, when disturbing, high-frequency and high-power currents traverse the primary winding 9, it is important that the secondary winding 5 shall be very closely inductively linked therewith in order that the energy of the disturbance may be quickly and expeditiously transferred from the line conductor 1 to the local or secondary circuit 8. A condenser 10 of the desired capacity is connected in multiple with the secondary winding 5 and also with a subsidiary discharge circuit 10^a comprising resistors 11 and adjustable spark gap members 12. The resistors 11 will usually be ohmic, but it will be understood that any device in which energy is dissipated or converted into another form of energy may be used. The spark gap members 12 are adjustable so that the proper spark gap for certain electrical conditions may be readily obtained. It is apparent that the electrical constants of the elements comprising my protective device may be varied and so related as to dissipate most effectively the energy of disturbances having quantities of energy and frequencies within fixed limited ranges.

When a high-frequency disturbance traverses the conductor 1 and, consequently, the primary windings of the series transformers 2, 3 and 4, it is absorbed by the particular secondary circuit or circuits which select it. To illustrate: the secondary circuit 8 is so constituted as to dissipate most effectively a disturbance of a certain amount of energy and of a certain frequency. The condenser 10 instantaneously absorbs the energy of this disturbance and subsequently discharges it through the discharge circuit 10^a. By reason of the combination of the condenser 10, the resistors 11 and the spark gap members 12, the discharge circuit 10^a may have a natural period of vibration which will greatly exceed that of the disturbance, the energy of which it is designed to dissipate. As the condenser discharges in the discharge circuit 10^a, the energy of the disturbance upon the conductor 1 is transferred into heat by means of the resistors 11 and the spark gap formed by the spaced members 12.

By connecting the condenser 10 in shunt to the secondary winding 5 of the transformer 2, the transmission line conductor 1 is instantaneously relieved of the high-frequency disturbance, inasmuch as the condenser absorbs the charge by reason of the close inductive interlinkage between the primary winding 9 and the secondary winding 5 when subjected to high-frequency impulses. When the quantity of electricity absorbed by the condenser 10 raises the potential of the condenser and subjects the spark-gap 12 to a sufficiently high voltage to effect a discharge, the auxiliary discharge circuit 10^a will oscillate at a frequency in excess of the original disturbance because of the low inductance of said auxiliary circuit. It will be apparent that the electrical constants of the condenser 10, the resistors 11, the spark-gap comprising the members 12 and the associated transformer windings and the like are so chosen as to permit, first, the condenser to instantaneously absorb the energy of the

disturbance impressed upon the transmission line conductor 1, and, secondly, to permit the condenser to discharge through a high-frequency auxiliary circuit, thereby dissipating the energy absorbed by the condenser.

From the foregoing description, it will be seen that a plurality of protective devices, as shown, may be inserted in series with each line conductor, each device being so constituted as to dissipate most effectively the energy of disturbances having frequencies and quantities of energy within limited ranges. In this manner, protection may be afforded to a system against disturbances of a very wide range of frequency and quantities of energy. Moreover, no ground connections or connections between adjacent transmission conductors are required, which conditions greatly affect the insulating properties of the transmission line. After the devices have been once installed, it is unnecessary to have frequent inspections, such as are required when electrolytic condensers are used. For this reason, the cost of maintaining my protective device in good working order is very low. As all the elements comprising my protective device are not subjected to extremely great differences of potential, the cost of furnishing them is very low also.

While I have shown and described a particular embodiment of my invention, it will be understood by 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 lightning arrester comprising a series transformer having a primary winding which is adapted to be connected in circuit with a line conductor and a secondary winding irresponsive to normal conditions of the system, means associated with the secondary winding for substantially instantaneously absorbing the energy of disturbances of more than a predetermined degree of severity, and energy-consuming means for subsequently dissipating the energy thus absorbed.

2. A lightning arrester comprising a series transformer having a primary winding which is adapted to be connected in circuit with a line conductor and a secondary winding irresponsive to normal conditions of the system, means associated with the secondary winding for substantially instantaneously absorbing the energy of disturbances of more than a predetermined degree of severity, and means comprising an energy-consuming element for subsequently dissipating such energy by effecting alternating discharges of higher frequencies than that of the original disturbances through said energy-consuming element.

3. A lightning arrester comprising a series transformer having a primary winding that is adapted to be connected in circuit with a line conductor and a secondary winding irresponsive to normal operating conditions but effective for abnormal conditions, a concentrated capacity element associated with the secondary winding for substantially instantaneously absorbing the energy of disturbances of more than a predetermined degree of severity, and a circuit connected in shunt to said capacity element for consuming the energy of the disturbances absorbed by said capacity element.

4. In a protective device, the combination with a line conductor, a secondary circuit inductively related thereto, and means irresponsive to normal operating conditions for transferring disturbing energy of abnormal frequencies impressed on the line conductor to the secondary circuit, of means embodied in the secondary circuit for instantaneously absorbing the energy of said disturbances, and means for subsequently dissipating substantially all of the absorbed energy as heat.

5. In a protective device, the combination with a line conductor, a secondary circuit inductively related thereto, and means irresponsive to normal operating conditions for transferring disturbing energy of abnormal frequencies impressed on the line conductor to a secondary circuit, of means comprising an energy-consuming device associated with the secondary circuit for effecting discharges of the disturbing energy through said energy-consuming device with frequencies exceeding the initial frequency of the disturbing energy.

6. In protective apparatus for an electrical system, the combination with a line conductor, and means associated therewith for instantaneously absorbing only the energy of abnormal high frequency disturbances, of auxiliary means associated with said first means for subsequently dissipating the said absorbed energy.

7. In protective apparatus for an electrical system, the combination with a line conductor, and means associated therewith for instantaneously absorbing only the energy of abnormal high frequency disturbances, of means which in conjunction with said absorbing means constitutes an oscillating circuit having a natural time period of vibration differing from the initial frequency of said disturbances for subsequently dissipating said absorbed energy.

8. In protective apparatus for an electrical system, the combination with a line conductor, and means associated therewith for instantaneously absorbing only the energy of abnormal high frequency disturbances, of auxiliary means comprising energy-consuming means and a spark gap connected to said energy-absorbing means for discharging said absorbed energy and in conjunction with said absorbing means constituting an oscillating

circuit for dissipating said absorbed energy at a frequency differing from the initial frequency of said disturbances.

9. In protective apparatus for an electrical system, the combination with a line conductor, and means loosely coupled therewith and irresponsive to normal line conditions for instantaneously absorbing only the energy of abnormal disturbances, of means connected in multiple with said first means for dissipating the energy absorbed by said first means.

10. In protective apparatus for an electrical system, the combination with a line conductor, and means loosely coupled therewith and irresponsive to normal line conditions for instantaneously absorbing only the energy of abnormal disturbances, of means, which in conjunction with said absorbing means constitutes an oscillating circuit having a natural period of vibration differing from the frequency of the initial disturbance, connected in multiple to said first means for dissipating the energy absorbed thereby at a frequency determined by the time constants of said oscillating circuit.

11. In protective apparatus for an electrical system, the combination with a line conductor, and means, normally loosely coupled therewith and irresponsive to normal frequencies but adapted to be substantially closely coupled therewith under predetermined excessive frequencies, for transferring only the energy of excessive frequencies to a secondary circuit, of a condenser associated therewith for absorbing the transferred energy and instantly relieving the line conductor of abnormal frequencies, and means associated with said condenser for dissipating said absorbed energy.

12. In protective apparatus for an electrical system, the combination with a line conductor, a secondary circuit and means for transferring only disturbing energy of an abnormal frequency to said secondary circuit, of means for effecting alternating discharges of a different frequency than that of the initial disturbing energy and dissipating the energy transferred and discharged.

13. In protective apparatus for an electrical system, the combination with a line conductor, a secondary circuit and means for transferring only disturbing energy of an abnormal frequency to said secondary circuit, of means embodying an oscillating circuit of different natural period from that of the initial disturbing energy for discharging and dissipating the disturbing energy of more than a predetermined degree of severity.

14. In a protective device, the combination with a line conductor and a transformer connected thereto and having primary and secondary windings that are inductively related only at abnormal frequencies, of a condenser connected in multiple to said secondary winding for absorbing the energy of abnormal frequencies transferred to the secondary winding and a subsidiary circuit comprising energy-consuming means connected in multiple to said condenser for dissipating the energy absorbed thereby.

15. In a protective device, the combination with a line conductor and a transformer connected thereto and having primary and secondary windings that are inductively related only when abnormal frequency disturbances traverse said primary winding, of a subsidiary tuned circuit connected in multiple to said secondary winding and comprising a condenser, a resistor and a spark gap device.

16. The method of protecting an electrical system from abnormal frequency disturbances which consists in absorbing the energy of said abnormal disturbances and subsequently dissipating said absorbed energy.

17. The method of protecting an electrical system, from abnormal frequency disturbances which consists in instantly absorbing the energy of said abnormal disturbances whereby the system is immediately relieved of excessive strains and subsequently dissipating the absorbed energy as heat.

18. The method of protecting an electrical system from abnormal frequency disturbances which consists in transferring to energy-absorbing means only the energy of the abnormal disturbances and subsequently discharging said absorbed energy in oscillations through energy-consuming means.

19. The method of protecting an electrical system from abnormal frequency disturbances which consists in instantaneously absorbing only the energy of said abnormal disturbances and subsequently dissipating said absorbed energy by producing oscillations of a frequency differing from the frequency of the initial disturbance.

20. The method of protecting an electrical system from abnormal frequency disturbances which consists in storing the energy of said abnormal disturbances in a condenser and subsequently discharging said condenser through resistance and a spark gap device.

In testimony whereof, I have hereunto subscribed my name this 25th day of Aug. 1914.

ALEXANDER CHERNYSHOFF.

Witnesses:
CLARENCE RENSHAW,
B. B. HINES.