June 5, 1934. E. R. EVANS 1,962,062

ELECTRICAL PROTECTIVE SYSTEM

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Fig. 1

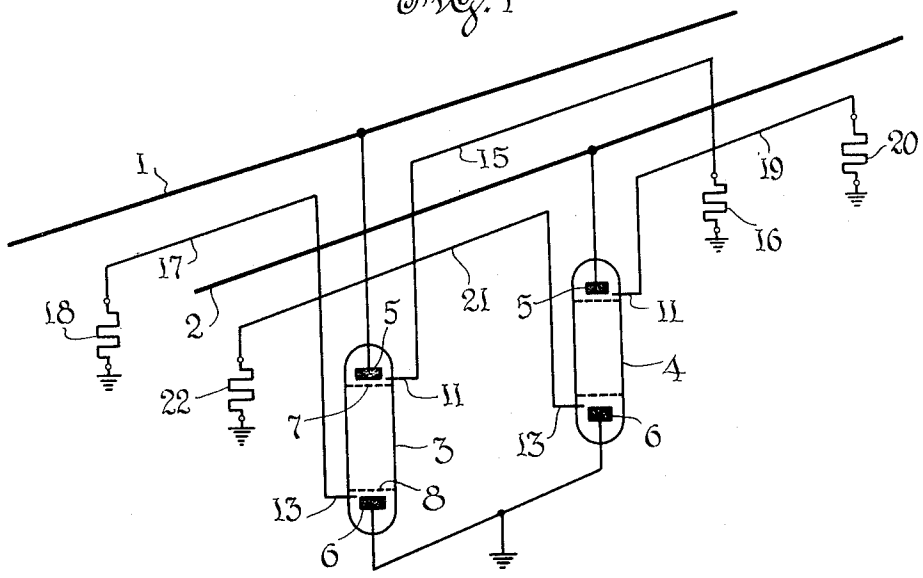
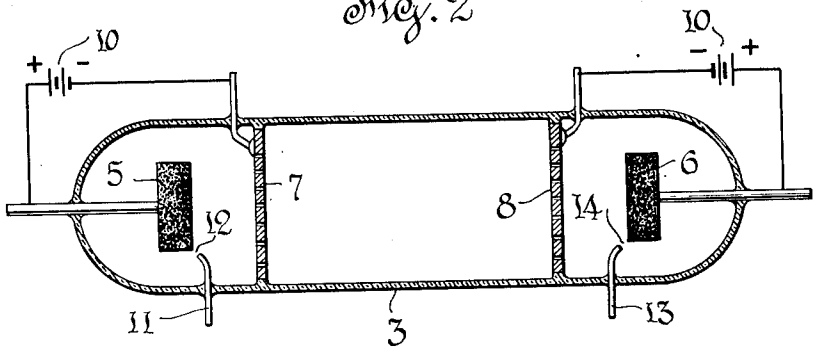


Fig. 2



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ELECTRICAL PROTECTIVE SYSTEM

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8 Claims. (Cl. 175—30)

My invention relates to protective systems for electrical apparatus and particularly to a system embodying space-discharge devices for protecting transmission line conductors, for example, against over-voltages resulting from atmospheric conditions or other causes.

One object of my invention is to provide a system of this character that shall be effective against relatively small over-voltages, whereas the prior systems have only been effective against over-voltages substantially greater than the normal line voltage in order to minimize the possibility of discharging at normal voltage.

Another object of my invention is to provide an improved system of the mentioned character in which the discharge apparatus shall be responsive to or affected by external conditions as distinguished from the prior systems which ordinarily have been responsive only to abnormal line voltage.

Other objects and advantages of my invention will appear from the following description of the embodiment thereof shown in the accompanying drawing wherein

Fig. 1 is a diagrammatic view of a system embodying the invention, and

Fig. 2 is a detail view of one form of discharge tube that may be employed in the system shown in Fig. 1.

Referring to the drawing, conductors 1 and 2 of a power transmission line, for example, are connected to ground through space-discharge devices 3 and 4, respectively, whereby over-voltages on said conductors are discharged to ground and the associated apparatus is protected against such voltages. The over-voltages may result from lightning discharges in the vicinity of the conductors 1 and 2 or from other causes.

In prior systems of this character, the discharge devices, usually termed lightning arresters, were so constructed that a discharge only occurred upon a substantial increase of voltage upon the normal line conductor, such as an increase amounting to 40% or 50% of the line voltage, in order to insure against the formation or continuation of a discharge at normal voltage. Other arresters have been designed to respond more readily to surges of steep wave front upon the line conductors. In accordance with the present invention, the discharge devices may have the usual margin or factor of safety during normal operation of the system but have a substantially lower ignition or arc-over voltage under certain conditions whereby more effective operation is insured.

To this end, the discharge devices 3, 4, having main or terminal electrodes 5 and 6, respectively, as shown in detail in Fig. 2, embody electrodes or elements arranged to affect the ignition voltage between the terminal electrodes, for example, electrodes arranged inside of an envelope enclosing the main or terminal electrodes. The envelope of the discharge device preferably contains a gaseous filling, such as argon or helium at a reduced pressure, or a filling of mercury vapor at a reduced pressure or a mixture of gas and vapor. The electrodes 5 and 6 are shielded from each other by perforated elements or shields 7 and 8 having openings though which the dischage current passes, the said openings being of such size that at the pressure of the gasfilling (or vapor filling), for example, of the order of 10–100 microns, ion sheaths formed upon the elements after a discharge occurs are effective to interrupt the discharge. For the purpose of forming the positive ion sheaths, the elements 7 and 8 are connected to the negative poles of batteries 10, the other terminals of which are connected to the terminals 5 and 6.

It will be understood that the gap between the terminals 5 and 6 will break down at a certain critical applied voltage. If the discharge or the current traversing the tube is oscillatory in character, it will be interrupted when the over-voltage on the line has ceased, on account of the positive-ion sheaths on the elements 7 and 8, in spite of the formation and existence of free positive ions and electrons in the discharge space. This effect of the elements 7 and 8 is probably largely a result of the absence of high-velocity electrons in the immediate vicinity of one or both of the electrodes 5 or 6, and these electrodes are preferably formed of a non-thermionic material which does not readily emit electrons, such as iron or graphite. The electrodes 5 and 6 should have considerable mass and may be cooled to limit electron emission. The elements or shields 7 and 8 may be made of chrome-iron alloy capable of being sealed to the glass container or envelope as indicated.

In accordance with the present invention, an electrode or conductor 11 is sealed into the envelope, the inner end of the conductor being spaced from the electrode 5 to provide a spark-gap 12. A similar conductor 13 is provided to form a spark-gap with the electrode 6. Where a gas filling at low pressure is utilized in the

discharge tube, the length of the spark-gaps may be increased over that shown if desired. The described spark-gaps are operative upon discharge to reduce the break-down voltage of the arrester by increasing the normal degree of ionization of the discharge path.

As shown in Fig. 1, the conductor 11 of the tube 3 is connected to electrostatic or charge-responsive means, such as an elongated conductor wire 15 extending parallel to the conductor 1 or otherwise disposed so as to be affected by external conditions affecting said conductor. The outer end of the conductor 15 is grounded through a leak resistance 16 to prevent the accumulation of charges thereon. The conductor 13 of tube 3 is similarly connected to a conductor 17, preferably extending in the opposite direction from conductor 15, and the leak resistance 18. The conductors 11 and 13 of the tube 4 are similarly connected to conductor 19, leak resistance 20 and conductor 21, leak resistance 22, respectively, associated with the conductor 2.

It will be apparent that the arrangement described is responsive to external conditions which induce electrical surges in the main line conductors to break down the gaps 12 and/or 14, thereby ionizing the gasfilling and reducing the arc-over or breakdown voltage of the discharge devices upon the occurrence of such conditions. The conductors 15, 17, 19 and 21 serve as collector elements which, being in the proximity of the line conductors 1 and 2, are similarly affected by atmospheric or other conditions which induce abnormal potentials upon said line conductors. The induced potentials upon the collector elements are therefore coincident with the abnormal potentials upon the line conductors and the ionizing discharges across the gaps 12 and 14 only occur at the proper time; i. e., when it is desirable that a discharge through the arrester should occur.

I claim:

1. A system embodying a space-discharge device for over-voltage protection of electrical conductors, the discharge device comprising spaced electrodes and means for varying the breakdown voltage between said electrodes, characterized in that said means is connected to a collector circuit separate from the conductor with which the discharge device is associated but in the proximity thereof so as to be responsive to external conditions which also affect said conductor.

2. A protective system for a line conductor subject to over-voltage surges comprising a discharge device connected to the line conductor and ionizing means for reducing the impedance thereof in response to conditions which influence the voltage of said conductor, said means including a second conductor in the proximity of said line conductor and insulated therefrom.

3. In combination, a power-distribution circuit, a discharge path associated therewith for discharging over-voltages on the circuit and means electrically independent of said circuit for ionizing a portion of said path in response to the occurrence of an electrical disturbance capable of producing an overvoltage on said circuit to lower the impedance thereof.

4. A protective system for a line conductor subject to abnormal surges of energy comprising an arc-discharge device connected to the line conductor, said device embodying two spaced electrodes and an auxiliary electrode, and means independent of said line conductor and including said auxiliary electrode for reducing the breakdown voltage of said discharge device in response to conditions which produce surges on said conductor.

5. A protective system for a line conductor subject to abnormal surges of potential comprising an arc-discharge device connected to the line conductor, said device embodying an ionizable discharge path, and means for ionizing said path to reduce the breakdown voltage of said device, said means including a collector element arranged to be inductively affected by atmospheric conditions which induce similar surges of potential upon the line conductor.

6. A protective system for a line conductor subject to abnormal surges of potential comprising an arc-discharge device connected to the line conductor, said device embodying an ionizable discharge path, and means for ionizing said path to reduce the breakdown voltage of said device, said means including two conductors extending from said discharge path in opposite directions substantially parallel to the line conductor, to be affected by atmospheric conditions which induce surges of potential upon said line conductor.

7. A protective system for a line conductor subject to overvoltages comprising an arc-discharge device including a sealed envelope filled with an ionizable gas or vapor and spaced terminal electrodes sealed therein, and means, including another electrode adjacent the gap between said terminal electrodes for ionizing said gas or vapor upon the occurrence of an overvoltage on said conductor.

8. A protective system for a line conductor subject to overvoltage surges comprising a space-discharge device connected to the line conductor, said device embodying ionizing means for the space-discharge path, and means including a charge-responsive collector in circuit with said ionizing means for reducing the impedance of said device in response to conditions affecting the potential of said collector.

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