Nov. 25, 1930. F. W. PEEK, JR 1,783,052

ELECTRIC DISCHARGE DEVICE

Filed March 2, 1926

Fig. 1.

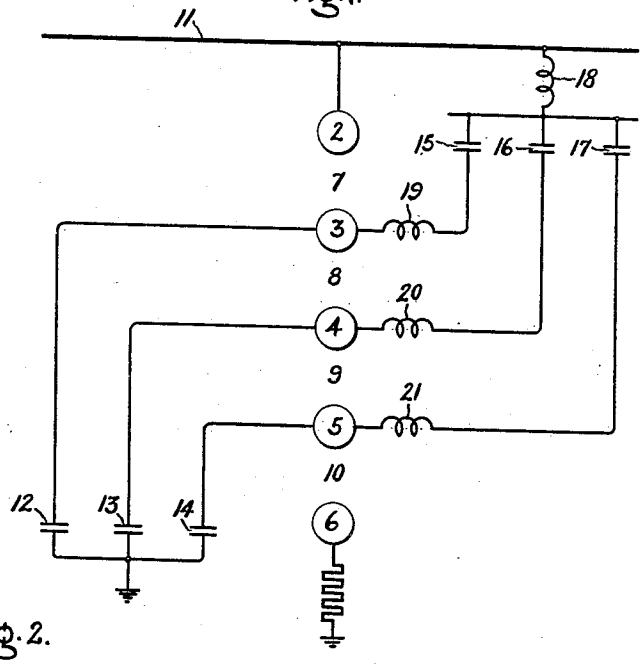
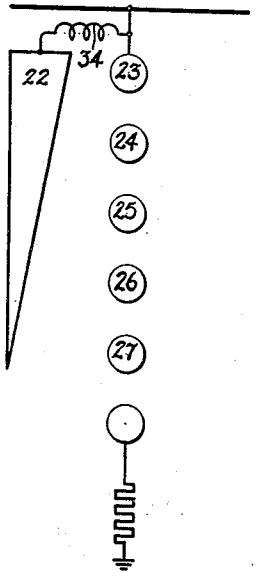


Fig. 2.



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UNITED STATES PATENT OFFICE

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ELECTRIC DISCHARGE DEVICE

Application filed March 2, 1926. Serial No. 91,684.

My invention relates to electric discharge devices. More in particular, it relates to discharge devices adapted for use as lightning arresters as, for example, to protect the lines and apparatus of an electric power system.

While it is known that if a number of gaps are placed in series in an electric discharge device, as in a multi-gap arrester, the spark-over voltage is somewhat less than the sum of the spark-over voltages of the individual gaps, nevertheless, I find that the reduction in voltage may be carried out to a much greater degree by increasing the capacity of some of the electrodes in the gap series with respect to ground. For example, I find that the spark-over voltage in a multi-gap arrester may, in fact, be made to approach the spark-over voltage of a single gap. I have further found that the total spark-over voltage can be brought back to normal by inserting capacities between the electrodes in the gap series and the line, so as to neutralize the effect of the capacities to ground.

It is one of the objects of my invention to provide a discharge device of the multiple gap type in which, under normal operating conditions, as for example, 60 cycle, the spark-over voltage approaches the sum of the spark-over for the various gaps in the series, while when a surge appears on the line the spark-over of the series approximates the spark-over voltage of a single one of the gaps. However, the novel features of my invention are hereinafter more fully set forth and claimed, reference being had to the accompanying drawing, in which Fig. 1 shows diagrammatically an arrester constructed in accordance with the principles of my invention; Fig. 2 shows a modified form of my invention.

Referring more in detail to Fig. 1 of the drawing, it will be seen that the discharge device in one form is represented as consisting of a series of electrodes 2, 3, 4, 5, 6, between which gaps 7, 8, 9, 10 appear. The device is shown connected with a line conductor 11, which may be considered as a line forming part of a power system. It will be seen that the topmost electrode 2 is connected with the line, while the last electrode 6 is connected to ground. As has been already indicated, if it is assumed that the discharge device consists only of the electrodes spaced apart as indicated, the total spark-over will be very materially less than the sum of the voltages corresponding to each gap. I have found, however, that if, for example, I connect the electrodes 3, 4, 5, respectively to ground through condensers 12, 13, 14, the spark-over voltage may be made to approximate the spark-over voltage of the single gap 7. On the other hand, I have also found that this situation may be neutralized by connecting the same electrodes, 3, 4, 5, through condensers 15, 16, 17, respectively, with the line conductor 11. The result of this arrangement is that the discharge device is left in a condition as though all of the connections indicated between the electrodes 3, 4, 5, and ground on one side and the line on the other side were eliminated. I have found that I can obtain the same results, as far as the normal operating voltages of the line are concerned, if I insert an inductance or inductive impedance 18 between the line and the condensers 15, 16, 17, and inductances of inductive impedances 19, 20 and 21, respectively, in the branches leading off from the electrodes 3, 4, 5 toward the line. I find that by inserting the impedances 18, 19, 20 and 21, as indicated, the spark-over voltage for normal operating voltage between the electrodes 2 and 6 is not materially affected, but I find further that whenever a surge, or an induced charge, or a lightning stroke, appears on the line 11, the discharge device is unbalanced and operates as though the branches containing impedances 19, 20 and 21 were not present. The effect is that for surges and abnormal voltages the discharge device will discharge practically as though there were only one spark gap 7, and after 7 breaks down, 8, 9 and 10 follow successively without appreciable increase in voltage. This differential action which results in a high spark-over voltage during normal or low frequency conditions and low spark-over voltages during high frequency or steep wave front voltages is insured by the provision of impedances

such as the impedance 18, or such as the impedances 19, 20 and 21.

The form of device shown in Fig. 2 involves the same principle as that involved in the device of Fig. 1. In Fig. 2 a graded capacitance is indicated by the sloping or V-shaped element 22. Between this element and the line an impedance coil 34 is interposed, which performs the same function as that performed by the coil 18 in Fig. 1. This element 22 is indicated as being common to the electrodes 23—27. Inasmuch as each electrode has a certain natural capacity to ground and to the surrounding structure and inasmuch as this capacity is graded in the reverse order from that indicated by the condenser element 22, this element 22 has the effect of counteracting or balancing the natural capacitance of the device and leaving the electrodes 23—27 as though both the natural and the supplied capacitance were eliminated, that is, they neutralize or balance each other. However, with respect to high frequency voltages or voltages having a steep wave front the impedance 34 operates to shut off the capacity 22, leaving the natural capacity effective; this unbalances the device so that with high frequencies the device discharges at a lower voltage just as is the case with respect to the type of apparatus shown in Fig. 1. Therefore, when an electric disturbance appears upon a line to which the device may be connected, the disturbance finds a smaller capacity between the electrodes 23 and 24 than there is, for example, between the electrode 27 and the ground. Consequently, a discharge takes place between the elecrodes 23 and 24 which is the beginning of a cascade discharge. The mode of operation is, therefore, the same as that of the device of Fig. 1 in which the discharge takes place first between the electrodes 2 and 3 which is also the beginning of a cascade discharge.

While I have illustrated, in connection with the drawing, certain embodiments of my invention, it will be understood that, in view of the disclosure, the invention may be varied in form without departing from the spirit thereof or from the scope of the claims contained herein.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. An electric discharge device having a series of gaps and an electrode on each side of each gap, the last electrode at one end of the series constituting one terminal electrode of the device and the last electrode at the opposite end of the series constituting another terminal electrode, the gaps adjacent to the terminal electrodes constituting terminal gaps, the remaining gaps and electrodes of the series being located between the terminal gaps, said remaining electrodes and gaps constituting intermediate electrodes and gaps, capacitance between each intermediate electrode and one of the terminals of the device, a corresponding balancing capacitance interposed between each intermediate electrode and the opposite terminal electrode of the device, and an impedance element interposed between one of the terminal electrodes of the device and said intermediate electrodes in series with the capacitance located between the same terminal electrode, and the intermediate electrodes whereby a differential spark-over characteristic is imparted to the device with respect to high frequency and low frequency currents.

2. A discharge device having a pair of terminal electrodes and a plurality of intermediate electrodes, all of said electrodes being arranged in series and each being separated from the other by a spark gap, a capacitance interposed between each intermediate electrode and each terminal electrode, and an impedance interposed between each intermediate electrode and one of the terminal electrodes, whereby a differential spark-over characteristic is imparted to the device with respect to currents of different frequencies.

3. A multi-gap discharge device having a pair of terminal electrodes and a plurality of intermediate electrodes, all of said electrodes being arranged in series and each being separated from the other by a spark gap, means for rendering the spark-over voltage of the series equal to, or substantially equal to, the sum of the spark-over voltages when a voltage of one frequency is applied, and means for imparting to the device a lower spark-over characteristic with respect to voltages of a higher frequency.

In witness whereof, I have hereunto set my hand this 27th day of February, 1926.

FRANK W. PEEK, JR.