

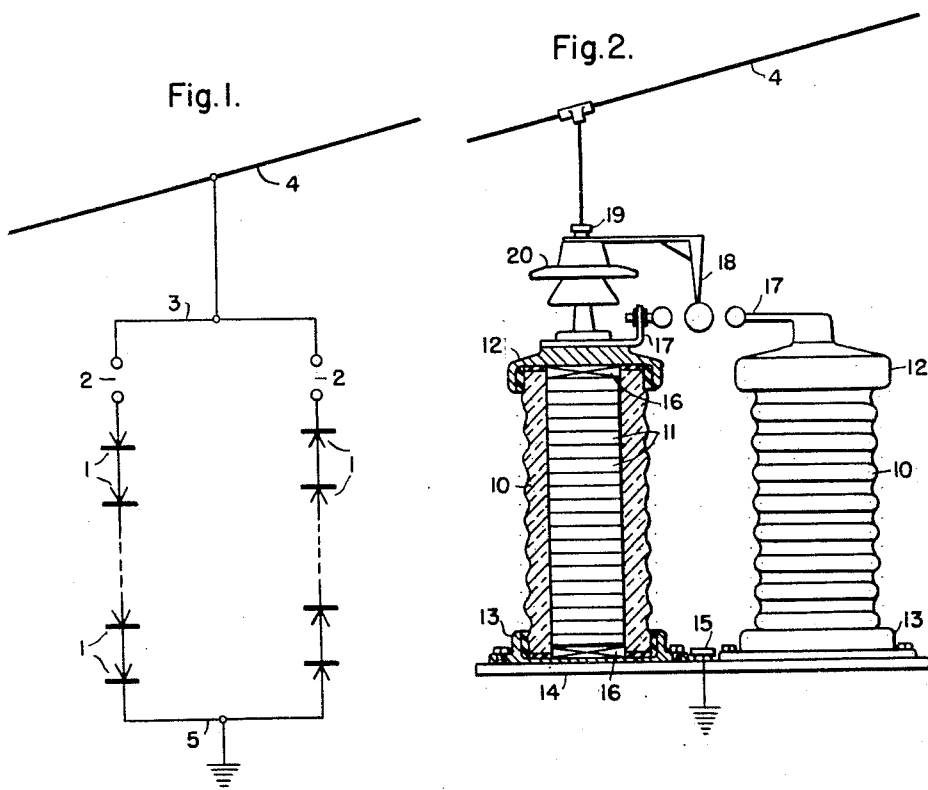
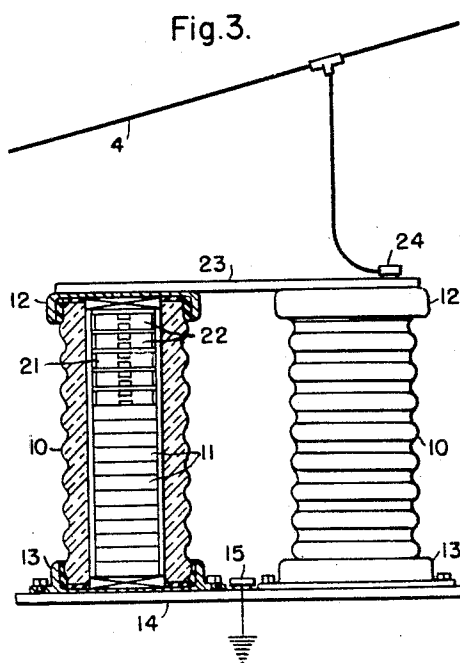
Sept. 18, 1956

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2,763,818

LIGHTNING ARRESTER

Filed Oct. 14, 1954



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1

2,763,818

LIGHTNING ARRESTER

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Application October 14, 1954, Serial No. 462,339

5 Claims. (Cl. 317—61)

The present invention relates to lightning arresters or overvoltage protective devices, and more particularly to a new type of lightning arrester utilizing semiconductor rectifier devices.

Lightning arresters are used for protection of electrical equipment against excessive voltage surges, such as lightning surges, and are usually connected between a line or a terminal of the protected device and ground. The arrester must be substantially a non-conductor under normal conditions, but when a voltage in excess of a predetermined value occurs, it must become conducting substantially instantaneously to discharge the surge. The voltage across the arrester itself during the discharge must not rise sufficiently to endanger the protected device, and after the surge has passed and the voltage has fallen to or near its normal value, the arrester must again become non-conducting and must interrupt the power current which tends to flow through the arrester due to the normal line voltage.

In conventional lightning arresters of the valve type, these requirements are met by the use of a valve element, or non-linear resistor, connected in series with a spark gap. The spark gap normally isolates the valve element from the line but sparks over at a predetermined voltage and allows surge current to flow to ground through the valve element, which has low resistance and thus a low discharge voltage under high current conditions. When the surge has been discharged, the valve element increases its resistance and reduces the power current to a small value which is readily interrupted by the spark gap. The valve elements usually used consist of granular silicon carbide with a binder of sodium silicate or other suitable material, and frequently with other constituents such as clay. The heterogeneous nature of this mixture and the difficulty of obtaining uniformity of the various constituents, especially of the silicon carbide, have made it very difficult to control the characteristics of these valve elements in manufacture, and the variability of the valve elements is a serious problem in conventional lightning arresters.

The principal object of the present invention is to provide a new type of lightning arrester in which the conventional valve elements are eliminated, and in which uniform and readily controllable characteristics are obtained.

Another object of the invention is to provide a lightning arrester in which semiconductor rectifier devices are utilized for discharging surge voltages with low voltage during the discharge, and for substantially interrupting the power current at the first current zero following a discharge.

Other objects and advantages of the invention will be apparent from the following detailed description, taken in connection with the accompanying drawing, in which: Fig. 1 is a schematic diagram illustrating the invention; and

Figs. 2 and 3 are somewhat diagrammatic views, partly in section, showing illustrative embodiments of the invention.

2

The lightning arrester of the present invention is shown schematically in Fig. 1. As there shown, the new arrester consists of two parallel-connected groups of elements. Each of these groups consists of a plurality of rectifier devices 1 connected in series, and a spark gap device 2 connected in series with the rectifier elements. The rectifiers are preferably semiconductor rectifier devices of the p-n junction type, such as silicon or germanium rectifiers. Rectifiers of this type are capable of carrying relatively large currents in the forward or conducting direction, with low voltage drop across the rectifier in the forward direction. These devices are also capable of withstanding relatively high voltages in the reverse direction with extremely low leakage currents.

The rectifier devices 1 of each of the two groups are connected in series with a spark gap 2 and the two groups are connected in parallel with the rectifiers of the two groups connected in opposite directions, that is, the forward or readily conducting direction of one group is opposite to that of the other group. The spark gap devices 2 may be connected together as indicated at 3, and connected to a line or other protected device 4, and the opposite ends of the two series groups of rectifiers are connected together at 5 for connection to ground. Any suitable number of rectifier devices may be used in series, depending on the voltage rating desired, and each of the parallel-connected groups therefore consists of one or more rectifier devices in series with a spark gap device.

In the use of this device, it is usually connected between line and ground, as shown. Under normal conditions, the spark gap devices 2 isolate the rectifiers 1 from the line so that the device is a non-conductor. Upon the occurrence of a voltage surge on the line 4 in excess of a predetermined magnitude, such as a lightning surge, one or the other of the spark gaps 2 will break down and become conducting. It will be understood that such voltage surges may be of either polarity, and will be in the forward direction of one or the other of the two parallel groups of rectifiers. If the magnitude of the surge exceeds the breakdown voltage of the gaps 2, the gap of the group of rectifiers which is in the forward direction for the polarity of the surge will arc over, and permit the surge to be discharged to ground through the rectifiers. The other group of rectifiers is in the reverse direction for the polarity of the surge, so that it presents a very high impedance and the associated gap 2 will not break down. The surge is discharged, therefore, through one or the other of the two groups of rectifiers, and the voltage across the arrester during the surge is only the sum of the relatively low forward drops of the rectifiers 1. The discharge voltage of the arrester therefore is quite low.

After the surge has been discharged, power current will continue to flow through the rectifiers 1 to ground until the next current zero of the line current, when the current passes through zero and reverses in polarity. The group of rectifiers through which the current has been flowing is then in the reverse direction with respect to the polarity of the current, and only an extremely small leakage current can flow through the rectifiers in the reverse direction. This current is so small that it cannot maintain a stable arc in the gap 2, and the current is easily interrupted by the gap. The other parallel group of rectifiers is, of course, in the forward direction of the current after the current zero, but since the gap of that group had not arced over, no current will flow. Thus, the arrester reliably interrupts the power current and again becomes a non-conductor at the first current zero following a discharge.

Fig. 2 shows somewhat diagrammatically a practical embodiment of the invention. In this embodiment, the two groups of rectifiers are contained in cylindrical housings 10 of porcelain, or other suitable weather-proof insu-

lating material. Each of the housings contains a stack of semi-conductor rectifier devices 11 disposed in the housing in series relation, the rectifier stacks of the two housings being arranged with their forward directions opposite to each other, as explained above in connection with Fig. 1. The housings 10 are closed at the top and bottom by metal fittings or caps 12 and 13 which may be secured to the housing in any suitable manner, as by cementing. The bottom caps 13 of the two housings may be secured to a metal mounting plate 14 which electrically connects the two groups of rectifier devices and which may be provided with a terminal device 15 for connection of a ground lead. The rectifiers 11 are preferably held in good electrical contact with each other and with the end caps by spring means indicated diagrammatically at 16. An electrode member 17 of any suitable type is mounted on the upper cap 12 of each housing in electrical contact therewith. A common electrode 18 is disposed between the two electrodes 17, to form separate spark gaps with them, and is provided with a terminal device 19 for connection of a line lead. The common electrode 18 may be supported in any suitable manner, and is shown as being mounted on an insulator 20 placed on top of one of the housings 10. It will be evident that this arrester is identical electrically to the diagram of Fig. 1, and its operation is as described above.

Fig. 3 shows another embodiment of the invention which may be utilized where open spark gaps may be undesirable. In this embodiment, the rectifier devices 11 are disposed in porcelain housings 10, as before, and spark gap devices 21, preferably consisting of a plurality of individual gaps 22 of any suitable construction, are placed within the housings 10 in series relation with the rectifiers 11. The housings 10 are mounted as described above in connection with Fig. 2, and a conducting plate or member 23 is secured on the upper caps 12 to electrically connect them together and may be provided with terminal means 24 of any suitable type for connection of a line lead. It will be seen that the operation of this arrester is the same as that previously described.

It will now be apparent that a new type of lightning arrester has been provided which completely eliminates the use of conventional valve elements, and therefore avoids the difficulties of non-uniformity and variable characteristics which have been serious problems in conventional arresters. The new arrester utilizes semiconductor rectifier devices which have very uniform characteristics which are readily controllable in manufacture, and thus accurately predetermined performance is obtainable. The characteristics of semiconductor rectifiers are very suitable for lightning arresters since they can discharge heavy surge currents with low voltage drop, and have very low reverse leakage current, so that the power current can easily be interrupted.

Certain specific embodiments of the invention have been shown and described for the purpose of illustration, but

it will be understood that various other embodiments and modifications are possible and are within the scope of the invention.

We claim as our invention:

1. A lightning arrester comprising two groups of elements connected in parallel, each of said groups consisting of at least one semiconductor rectifier device and a spark gap device connected in series, the rectifier devices of the two groups being connected in opposite directions.
2. A lightning arrester comprising two groups of elements connected in parallel, each of said groups consisting of a plurality of semiconductor rectifier devices and a spark gap device connected in series, the rectifier devices of the two groups being connected in opposite directions.
3. A lightning arrester comprising a first group of series-related semiconductor rectifier devices, a spark gap device connected in series with said rectifier devices, a second group of series-related semiconductor rectifier devices, a second spark gap device connected in series with said second group of rectifier devices, means for connecting the two spark gap devices to a common terminal means, and means for connecting together the ends of the two groups of rectifier devices opposite to the spark gap devices, the rectifier devices of the two groups being disposed with their conductive directions opposite to each other.
4. A lightning arrester comprising a pair of insulating housings, a plurality of series-related semi-conductor rectifier devices in each of said housings, a spark gap device in each housing in series relation with the rectifier devices, means for connecting the spark gap devices of both housings to a common terminal means, and means for connecting together the other ends of the two series of rectifier devices, the rectifier devices of the two housings being disposed with their conductive directions opposite to each other.
5. A lightning arrester comprising a pair of insulating housings, a plurality of series-related semi-conductor rectifier devices in each of said housings, means for connecting one end of the series of rectifier devices in one housing to one end of the series of rectifier devices in the other housing, the rectifier devices of the two housings being disposed with their conductive directions opposite to each other, an electrode member supported on each housing and connected to the other end of the series of rectifier devices therein, and a common electrode member supported between said first-mentioned electrode members and forming spark gaps therewith.

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