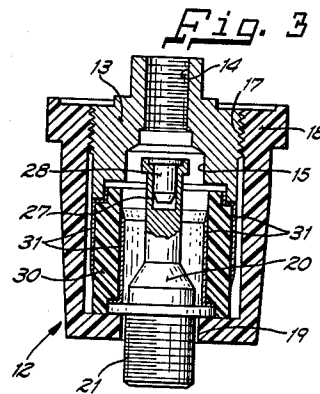
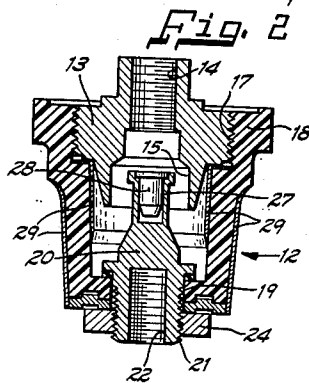
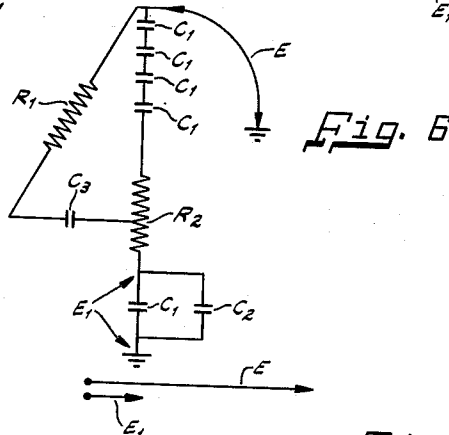
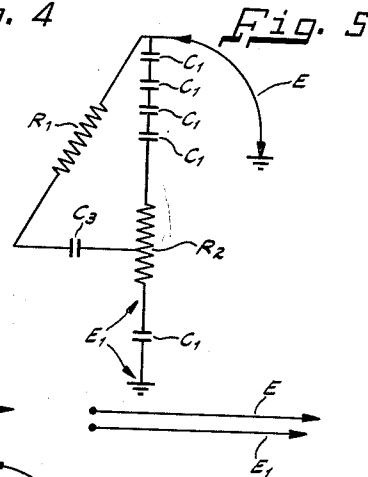
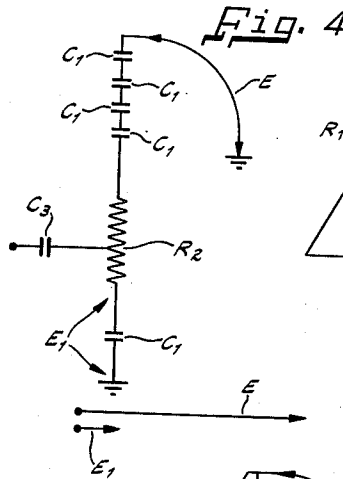
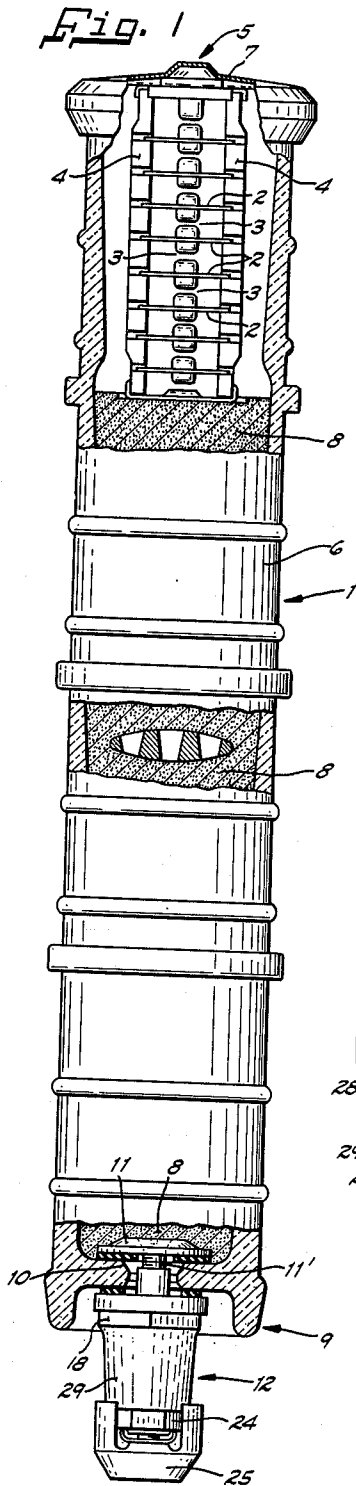


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LIGHTNING ARRESTER ISOLATOR DEVICES

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LIGHTNING ARRESTER ISOLATOR DEVICES
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This invention relates generally to improvements in overvoltage protective equipment and more specifically to isolator devices for lightning arresters.

Isolators are frequently utilized with lightning arresters of the type having a plurality of electrodes which define a series of spark gaps and a negative resistance material in series with the spark gaps. Isolators are generally connected in series with the negative resistance element of the lightning arrester and comprise a housing and upper and lower spaced apart electrodes which define a spark gap there-in-between. In operation the isolator does not ordinarily function unless an unusually heavy discharge is experienced across the isolator gap or in the event of continuous power follow current flow due to dynamic overvoltages at which time the isolator functions to permanently open the circuit to ground.

A typical form of prior art isolator is illustrated in the U.S. patent to Herman O. Stoelting, No. 2,551,858, issued on May 8, 1951, for Resistor Type of Isolators for Lightning Arresters, owned by the assignee of the present invention.

Prior art isolators of this type are generally provided with an upper electrode which surrounds in spaced apart relation a lower electrode which has an explosive cartridge associated therewith. When heavy discharges appear across the isolator gap as a result of, for example, a breaking down of the negative resistance element of the lightning arrester, spark over and heating of the explosive cartridge occur which cause the cartridge to explode thusly moving at least one electrode away from the other electrode and permanently opening the circuit to ground. In some prior art devices actual rupture of the isolator housing is intended to separate the electrodes and ground leads.

Isolators of this general type have been used effectively for a number of years. However some difficulty has been experienced in their use particularly on a humid day when a dew or light frost which is in the process of melting collects on the arrester housing. When this condition occurs dirt on the arrester housing absorbs enough moisture to be slightly conductive. Leakage current may then occur along the outside of the arrester housing and cause a voltage to be impressed across the isolator gap. The leakage current in passing over the housing will dry out the path it follows and then will stop flowing preparatory to finding another "conductive" path on the housing. When another damp path is established the above process will be repeated.

In cases of severe dampening of the arrester housing such as occurs during de-frosting conditions, the leakage resistance from the line lead to the hangar bracket becomes relatively low and the total line voltage may appear across the isolator gap.

In any event the passage of leakage current over the arrester housing will tend to cause breakdown of the isolator gap at normal operating voltages and radio interference voltages will develop.

The same condition will cause heating of the powder in the cartridge which, though insufficient to cause explosion of the cartridge, is sufficient to seriously alter the effectiveness of the cartridge, thusly leading to deterioration and destruction of the cartridge. This heating of the powder, in actuality, constitutes an accelerated life test of the powder since there is a broad range of tem-

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perature values below that sufficient to ignite the powder but which will cause rather rapid deterioration of the powder.

Another detrimental aspect that may also occur in prior art devices, when subjected to these conditions, is that the overvoltages may cause serious tracking of the plastic isolator housing and consequent breakdown of same.

Some attempts have been made by the prior art devices to remedy these deleterious operating conditions, which by and large, involve the incorporation of a resistor to bridge the isolator gap thusly providing a path through which any accumulated charges may pass to the lower isolator electrode.

While this approach to the problem has been generally successful for some applications, it tends to be impractical for others, particularly in the case of low voltage arresters.

Where the sparkover voltage of the internal arrester gap is less than the sparkover voltage of the isolator gap upon sparkover of the arrester gap this voltage is impressed over the isolator gap. If the isolator gap does not spark over or if there is a sufficient time delay before this gap sparks over, considerable damage to, or complete destruction of the resistor may take place as a result of the heat generated by the current flowing through the resistor.

In order to raise the withstand voltage rating of the resistor to a value approximately equal to that of the internal arrester gap to avoid this condition, a relatively large resistor element would have to be utilized which in addition to increasing the cost of the device greatly increases the size of the isolator.

We have found that by utilizing a capacitance shunt around the isolator gap and cartridge that all the advantages found in utilizing resistance shunts are retained in addition to solving the before mentioned problem of shunt element damage.

In this connection due to the fact that a capacitance element has a negligible resistance parameter, power losses and accompanying heat generation are minimized (almost nonexistent), hence damage and deterioration of the shunt element and explosive cartridge is prevented and overall isolator performance improved.

It is therefore an object of this invention to provide a capacitance shunted isolator gap which will have a minimal amount of I²R losses and which will have no tendency of being destroyed as a result of heat generation therewithin. Another object of this invention is to provide an improved lightning arrester isolator (circuit interrupter) which will eliminate radio interference caused by spark over of the isolator gap due to leakage currents.

Another object of this invention is to provide a lightning arrester isolator which will pass leakage currents around the isolator gap and which will experience very little or no temperature rise tending to deteriorate the powder in the isolator cartridge.

A further object of this invention is the provide a lightning arrester isolator which will have improved voltage distribution and which will provide "in phase" distribution of voltage between line and ground.

A still further object of this invention is to provide a lightning arrester isolator which is inexpensive, of a realistic size and which has a shunt element that will resist breakdown during relatively long periods of electrical stress.

Other objects and advantages of our invention will be apparent from the following description of the preferred embodiments of the invention taken in connection with the accompanying drawings in which:

FIGURE 1 is a partially cutaway elevational view of a lightning arrester in combination with the isolator device of the invention.

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FIGURE 2 is a cross-sectional view in elevation of the isolator device of the invention.

FIGURE 3 is a cross-sectional view in elevation of a slightly modified embodiment of the isolator device of the invention.

FIGURE 4 is a schematic circuit diagram illustrating a clean and dry arrester assembly.

FIGURE 5 is a schematic circuit diagram illustrating a contaminated arrester assembly.

FIGURE 6 is a schematic circuit diagram illustrating a contaminated arrester assembly with the isolator device of the invention.

Referring now to the drawings and in particular to FIG. 1 reference character 1 indicates the lightning arrester generally which consists of a plurality of electrode conducting members 2 which define a series of spark gaps 3. The electrodes 2 are mounted on upright supporting members 4 which are positioned at the line end 5 of the arrester. The arrester 1 may have a cylindrical ceramic body housing 6 and an upper cover or cap portion 7. A negative resistance valve material 8 fills the interior of the housing 6 below the spark gaps 3 and is in series relation thereto.

An aperture 10 in the housing 6 at the ground end 9 of the arrester is provided and an apertured lower arrester terminal electrode 11 extends cross the aperture 10. A threaded bolt 11' extends through the electrode 11 and out of the aperture 10.

The isolator 12 is positioned at the ground end 9 of the arrester 1 and is generally exterior to the lightning arrester housing 6 and in series with the negative resistance valve element 8.

Referring now to FIG. 2 the isolator 12 comprises an upper electrode 13 having an axial threaded bore 14 therethrough which is somewhat enlarged at one end 15. Threaded bolt 11' is received in the threaded bore 14 of electrode 13 and serves to affix the isolator to the arrester. An intermediate portion of isolator electrode 13 has external screw threads 17 thereon which engage an insulating isolator body member 18.

The lower portion of body member 18 has an aperture 19 which receives a portion of a lower electrode 20 therein. The lower electrode 20 has external screw thread 21 on the lower portion thereof and a threaded recessed portion 22 therein which accommodates a threaded bolt 24. As can be seen from FIG. 1 the bolt 24 coacts with a lower cap 25 to correctly position the ground leads (not shown) and to enclose one end of the isolator.

The upper end of electrode 20 is received in spaced apart relation in the enlarged bore portion of upper electrode 13. A shell like recessed portion 27 of the electrode 20 is provided which carries an explosive charge in the form of cartridge 28.

A portion of the inner surface of body member 18 in contact with the upper electrode 13 may be coated with a conducting compound 29 and the same or a similar conducting compound may be utilized to coat the lower portion of the exterior of the housing 18. The body portion 18 is of a ceramic or other material having a high dielectric constant. It can thusly be seen that the conductive coatings 29 and the portion of the high dielectric housing therein between constitute a capacitance which is in shunt relation to the gap between electrodes 13 and 20.

A modified form of the invention is illustrated in FIG. 3. The modification of FIG. 3 is substantially similar to that of FIG. 2 except that an intermediate member 30 is placed around the lower electrode 20. Intermediate member 30 is positioned inwardly of the housing 18 and is in contact with the upper electrode 13 and the lower electrode 20. The intermediate member 30 is of a material that has a very high dielectric constant and is preferably of barium titanate which has a dielectric constant of 1200. A conductive coating compound 31 is molded

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or otherwise adhered to the upper outer surface of the member 30 and to the lower inner surface of the member so that a portion of the outer coating is in contact with the upper electrode 13 only and a portion of the inner coating is in contact with the lower electrode 20 only. As before the combination of coating 31 and member 30 comprises a capacitor.

Note especially that in both embodiments that the coatings on one side of the high dielectric material do not provide a complete electrical circuit between electrodes as this would lead to short circuiting of the isolator gap. While coatings of the type described give the best performance, it is conceivable that the combination of the electrodes and high K member could themselves provide a capacitance shunt around the gap without requiring conductive members or coatings other than the electrodes themselves.

In explaining the improved operation of the device reference will be made to FIGS. 4-6 wherein

C_1 = Normal capacitance across gap and isolator electrodes

C_2 = Capacitance added to shunt isolator gap

C_3 = Capacitance from hangar to valve element

R_1 = Leakage resistance along arrester housing

R_2 = Valve element resistance

FIG. 4 indicates the ideal and rarely achieved circuiting of a lightning arrester and isolator of the prior art type. Here since the lightning arrester is clean and dry very little of the E voltage will be impressed across the isolator gap and radio interference and cartridge heating will be minimal.

FIG. 5 however represents the true circuiting of a lightning arrester in service which has developed a damp dirt film on the arrester housing. Here the leakage resistance R_1 along the arrester housing caused by this contaminating condition of the arrester housing leads to a situation where all or a goodly part of the E voltage is impressed across the isolator gap as E_1 voltage. As previously explained the fact that close to total line voltage appears across the isolator gap leads to premature breakdown of the gap causing radio interference and cartridge heating as well as tracking and breakdown of the plastic housing of the isolator.

FIGURE 6 shows the true circuiting, in the field, of our improved device. As can be seen the E_1 voltage is only a small portion of the line voltage E since the isolator capacitance shunt C_2 effectively limits the voltage across the isolator gap to a value which will not spark over the gap even under the very worst contaminating conditions. As an example a capacitor having a value of 3000 μf . will limit the voltage across the isolator gap to a maximum value of 1 kv. under the very worst contaminating conditions possible on a 9 kv. device. It is to be noted that although the shunt capacitance across the isolator gap functions to prevent voltage buildup across the isolator gap during normal line conditions that upon excessive current flow it does not materially alter the flow thereof.

In addition to the already recited advantage of this construction another beneficial result obtained is that there is very little danger of physical damage being done to the dielectric member as a result of isolator gap delay during surges as would be the case in prior art devices which utilize a resistor shunt.

Another advantage obtained by our structure is that the size of the isolator may be kept relatively small since oversized capacitance elements are unnecessary. Our construction also results in an inexpensive isolator construction having improved operating characteristics and having little or no tendency of malfunction.

While two particular embodiments of the invention have been shown and described, it will be obvious to those skilled in the art that various changes and modifications can be made therefrom without departing from the invention and, therefore, it is intended in the appended

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claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

We claim:

1. The combination of a lightning arrester having one end connected to a power line and a circuit interrupter in series with the other end of said lightning arrester, wherein said circuit interrupter comprises a pair of spaced apart terminals defining a spark gap thereinbetween, a housing holding said terminals in releasable spaced apart relation, one of said terminals having an axial bore and the other of said terminals being received in said axial bore, an explosive cartridge secured to said other terminal within said housing and adjacent said one terminal, and means in substantially surrounding relation to said terminals for providing a capacitance in shunt to said spark gap, said capacitance being formed between electrodes of high conductivity separated by a dielectric of relatively high dielectric constant, whereby leakage currents are normally by-passed around said explosive cartridge and deterioration of said cartridge due to temperature buildup resulting from said leakage currents, arcing over said gap is eliminated, said capacitance limiting the voltage across said spark gap, resulting from the flow of power line frequency leakage current through said capacitance, to a magnitude below the power line frequency sparkover potential of said spark gap.

2. The combination of a lightning arrester and an isolator device on the ground side thereof and in series relation therewith, said isolator comprising a pair of upper and lower spaced apart terminals defining an isolating gap therebetween, a housing surrounding said terminals, an explosive cartridge secured to one of said terminals, a member having a high dielectric constant spaced inwardly from said housing and in contact with each of said electrodes, first means of high conductivity extending along the outer periphery of said member and in contact with one of said electrodes, second means of high conductivity extending along the inner periphery of said member and in contact with the other electrode, whereby said member and said first and second means constitute a capacitance shunt path around said isolator gap for leakage currents through said arrester to ground and prevent said leakage currents from sparking over said isolator gap, said capacitance limiting the voltage across said isolator gap, incident to the flow of power line frequency leakage current through said capacitance, to a magnitude below the power line frequency sparkover potential of said gap.

3. In combination a lightning arrester having one end adapted to be connected to a power line, and an isolating device comprising a first terminal connected to the other end of said lightning arrester and having a second terminal spaced apart from said first terminal and defining an air gap therebetween and being connected to ground, a housing surrounding said terminals, explosive means within said housing operable in response to the flow of excessive current between said terminals to permanently disconnect said second terminal from ground, a member having a high dielectric constant surrounding one of said electrodes, means of high conductivity on the inner and outer surfaces of said member, said means on the inner surface of said member being in electrical contact with one terminal and said means on the outer surface of said member being in contact with the other of said terminals, whereby said member and said means on

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said inner and outer surfaces thereof constitute a capacitance in shunt to said air gap for leakage currents through said arrester to ground, said capacitance limiting the voltage across said air gap, resulting from the flow of power line frequency leakage current through said capacitance, to a magnitude below the power line frequency sparkover potential of said air gap.

4. The combination of a lightning arrester and an isolator device on the ground side thereof and in series relation therewith, wherein said isolator comprises a pair of upper and lower spaced apart terminals defining an isolating gap therebetween, an explosive cartridge associated with one of said terminals, a housing composed of a material having a high dielectric constant surrounding said spaced apart terminals, first means of high conductivity on the exterior of said housing in electrical contact with one only of said terminals, second means of high conductivity on the interior of said housing in electrical contact with the other only of said terminals, whereby said first and second means of high conductivity and said housing constitute a capacitance in parallel with said isolating gap for leakage current through said arrester to ground, said capacitance limiting the voltage across said isolating gap, incident to the flow of power line frequency leakage current through said capacitance, to a magnitude below the power line frequency sparkover potential of said isolating gap.

5. The combination of a lightning arrester and an isolator device in series relation therewith, said isolator including a pair of spaced apart terminals defining a spark gap therebetween and means responsive to flow of excessive current between said terminals for permanently opening the circuit to ground of said lightning arrester, a housing surrounding said pair of spaced apart terminals, and capacitance means constructed and arranged to be in shunt with said spark gap for bypassing leakage current from said arrester to ground around said spark gap, the electrodes of said capacitance means being of high conductivity and being separated by a dielectric of high dielectric constant.

6. The combination of a lightning arrester and an isolator connected in series relation between a power line and ground, said isolator including a pair of spaced apart terminals defining a spark gap therebetween, one of said terminals being connected to said lightning arrester and the other being connected to ground, said isolator also including means responsive to the flow of excessive current between said terminals to open the circuit between said arrester and ground, a capacitance having electrodes of high conductivity separated by a dielectric of high dielectric constant, said capacitance being connected in shunt to said spark gap and bypassing leakage currents from said arrester to ground around said spark gap, said capacitance limiting the voltage across said spark gap, resulting from the flow of power line frequency leakage current from said arrester through said capacitance to ground, to a magnitude below the power line frequency sparkover potential of said spark gap.

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