LIGHTNING ARRESTER LEAKAGE CURRENT AND DUTY MONITORING SYSTEM

FIG. 1.

FIG. 2.

FIG. 3.

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The present invention relates to monitoring the duty on and condition of lightning arresters while they are in service, and particularly to a test set means employed in the ground circuit of an arrester as the monitoring means.

The purpose of a lightning arrester is to protect both the service of supplying electrical energy to consumers and equipment against damage by transient overvoltages. The duty imposed upon an arrester consists of the operation it must perform. Ordinarily, the arrester stands by with 60-cycle voltage impressed across its terminals. At some time during which the arrester is not in service, the transient voltage appears at its terminals. If it is high enough, the arrester may operate and surge current flows through the arrester to the ground. The surge current may or may not initiate follow current. If follow current flows, it is an added burden on the arrester. When it is interrupted, the arrester has completed its operating cycle and returns to its insulating state with only 60-cycle voltage impressed on it. The duty on the arrester thus consists of the continuous normal system voltage to which it is subjected, the frequency with which it discharges, the character of the surge current it is called upon to pass, and the follow current.

 Arresters are subject to the line-to-ground system voltage continuously, practically speaking. The total time during which an arrester discharges in its career may be at most a few seconds, the remainder of its time being spent in idleness, merely holding off the system voltage. Thus, it is expected to do as well as any insulation though it may have a small leakage current.

Inside the arrester housing are disposed the components that ordinarily comprise the complete arrester. These components include the spark gap structures, grading resistances or capacitors or both connected across the gaps, and the valve blocks which are voltage sensitive, non-linear resistors, usually made of silicon carbide. If these components become damaged, shorted or otherwise adversely affected, such as when moisture seeps into the arrester housing, a change in arrester grading current will occur and this change can be detected and measured by a milliammeter located in the ground circuit of the arrester.

On the outside of the arrester, conducting and semi-conducting substances settle on the insulated housing which can thereby provide another leakage current path to ground. Such a current flow is generally called contamination current, and like the grading current, can be detected and measured in the ground circuit of the arrester.
main grounded as long as the panel is open thereby protecting those personnel inspecting and maintaining the device.

The novel features characteristic of the invention both as to its organization and method of operation together with additional objects and advantages thereof will be best understood by reading the following description in connection with the accompanying drawing in which:

FIGURE 1 is a schematic diagram of the arrester condition monitoring means constructed in accordance with the principles of the present invention;

FIG. 2 is an elevation view showing the monitoring means of FIG. 1 in combination with a lighting arrester device; and

FIG. 3 is a schematic circuit diagram of the combination shown in FIG. 2.

In FIG. 1 is shown applicant's unique combination of parts for monitoring the condition of an arrester device and the duty imposed thereon. The combination forms a measuring and indicating instrument generally designated 10 having an input terminal lead 14 secured in an insulating bushing 7 which in turn is secured in the top side of the instrument housing or cabinet generally designated by dash line enclosure 12 in FIG. 1.

Instrument 10 is connected to the ground lead or terminal of an arrester 1 by the lead 14 (FIG. 2), and housing 12 may be adapted to be combined with the arrester housing in any suitable manner, or instrument 10 may be separately mounted depending upon the installation and environment in which it is employed. The arrester is connected to ground through the instrument components during normal operation of the arrester and instrument 10.

Lead 14 first connects the ground lead or terminal of the arrester to a grading impedance 16 that separates a meter 20 from the arrester. Impedance 16 may take the form of a resistor which is designed to keep the voltage on the meter low at all times except of course during the periods of high current surges. Meter 20, however, is normally short circuited by a switch 18 which when closed obviously conducts all current, including surge current, around the meter to ground. The switch 18 is opened only when it is desired to take a reading of arrester leakage current, and a comparison of such readings from time-to-time will indicate if the grading resistors or capacitors contained within the arrester housing have become damaged, contaminated or otherwise adversely affected such as when moisture seeps into the arrester housing. As is easily seen, switch 18 and meter 20 provide a quick, simple and effective means for determining the condition of arrester components by measuring leakage current while the arrester is being used in the system it is protecting.

Meter 20 may be a millimeter such as used in the device shown and described in copending application 485,295 filed September 7, 1965, by John B. Britain and Edward F. W. Beck and assigned to the present assignee. A multiplier switch 22 is used to place a multiplying resistor 24 across the meter for the purpose of reading arrester contamination currents which can be considerably higher than grading currents flowing through arrester resistors or capacitors. If and when contamination currents are indicated, the surface of the arrester should be cleaned. Multiplier switch 22 normally remains closed.

Meter 20 is further protected by a film cutout 26 or similar device designed to short out should a high current surge occur while the meter is being read, i.e., while switch 18 is open. A film cutout device may consist of two metal discs or plates separated by a thin insulating film which punctures upon application of a certain level of potential thereacross. Obviously, other means may be used to protect the meter from surge currents while it is being used.

In order to determine the condition of the spark gaps enclosed in the arrester, instrument 10 is provided with a replica spark gap means 28 that is a duplicate of the arrester spark gaps and therefore encounters and handles the same duty (surge currents, follow currents, system potentials, etc.) as the arrester gaps. Replica spark gap 28 (along with gap means 30) may be disposed in or form a part of a gap subassembly generally designated by dash line enclosure 32. Subassembly 32 can be adapted to be easily removed from the circuit and its supporting structure (not shown) for visual inspection or replacement if need be. In any case, the gaps in subassembly 32 are easily and quickly inspected for burned or melted surfaces and other forms of physical damage that may have resulted from having experienced excessive duty.

Across the lead connectors that place subassembly 32 in the circuit may be connected an automatic spring closing means 34 that shorts the lead connector together when the subassembly is removed thereby maintaining the conductive path to ground from the arrester device, the condition of which is of concern. Spring closing means may take any convenient form that allows itself to be opened by subassembly 32 or a portion thereof when it is inserted into its supporting structure (not shown) and shorted when the subassembly is removed from its supporting structure.

Subassembly 32 contains another spark gap means 30 which is designed to give further information concerning the duty encountered by the arrester device. Gap 30 can take the form of a mirror gap which may comprise two polished hard copper discs spaced apart .030 of an inch. These discs are marked by current surges arcing across the gap. The size of the marks is substantially proportional to the amount of surge current encountered by the arrester. The color and other characteristics of the marks make possible the determination of surge current polarity and duration. By a simple visual inspection of gap 30 (and gap 28) a wealth of information can be obtained about the arrester while it remains in service.

To count the number of times current surges have been passed by the arrester device there is provided a surge counter 40 (only representatively shown) connected in electrical series between grading resistor 16 and ground. Counter 40 may comprise a solenoid actuated ratchet wheel operating a numbered drum for visual presentation. The solenoid can be actuated by a resistor or other pediment means such as a connected capacitor designed to receive the surge currents to be counted. Current through the resistor charges the capacitor and the capacitor in turn discharges through the solenoid thereby electrically actuating it for mechanical performance. Such counters are well known and the specific design of the surge counter forms no part of the present invention; other suitable surge counting devices may be used in the novel arrangement disclosed herein.

In order to protect the components comprising test instrument 10 from the weather, cabinet 13 is designed to completely enclose the instrument and is provided with a door 11 (FIG. 2) to permit access to the instrument. Inside the cabinet and in front of the open door opening can be located an instrument panel (not shown) designed to support such components as the meter 20, the switches 18 and 22, the front end of gap assembly unit 32 and the surge counter 40 for ready observation by the personnel using the instrument. Behind the panel can be located the wiring, connectors, resistors, spring shorting means 34 and grounding switch 36. For maintenance and repair purposes, the panel may be hinged mounted to swing open. In such a case it would have a handle means (not shown) mechanically interlocked with a by-pass switch 36 that must close and therefore ground the input terminal (and thus, all internal parts) of instrument 10 before the panel could be opened.
Such an interlock is a safety feature for the protection of personnel working with the instrument.

In FIG. 2, is shown an embodiment of the invention in which instrument 10 is physically combined with the arrester device. Arrester 1 is secured to the top of instrument cabinet 12 and may be insulated therefrom by an insulating base or separator. Arrester ground lead 14 can extend from insulating bushing 7 located in housing 12 to a terminal means located on the base of the arrester device. Where instrument 10 is separately mounted from arrester 1, say on the support pedestal or frame work of a large arrester, lead 14 would extend the distance between the instrument and arrester. Thus, FIG. 2 shows only one embodiment of the invention since instrument 10 can be mounted in any convenient location.

FIG. 3 is a schematic circuit diagram in which the arrester components and instrument 10 are representatively shown to clearly depict the circuit relationship of arrester 1 and monitoring instrument 10. Spark gaps 4, grading resistances 5 and valve blocks 6 which are nonlinear resistances generally represent well known arrester components that are housed in an insulating structure generally designated in FIG. 2. Gaps 4 may be capacitance gridded or they may be both capacitance and resistance gridded. In any case, it is the condition of the above named components along with the insulated housing that instrument 10 continuously monitors while they protect the system represented by line 2 from damaging over voltages and surge currents.

From the foregoing description it should now be apparent that a unique arrester monitoring means and test instrument has been disclosed that allows both continuous monitoring of the arrester at normal system voltages and convenient examination whenever desired without the onerous and costly task of removing the arrester from the system it serves. The novel means disclosed herein provides a complete test for the arrester; that is, all arrester components can be checked for the total duty they have encountered as well as component leakage current which gives indication of the condition of the valve blocks and grading resistance or capacitance. In addition, by simply changing the current range of a meter, surface contamination of the arrester may be quickly checked. All of these tests are effected by the very simple and easy act of looking at the applicant's unique instrument and novel combination of components. Nothing more is required other than the writing down of meter readings in order to compare readings over a period of time for the purpose of discerning a change in arrester leakage current. And this operation can be performed by a recording type instrument (not shown) that would continuously record leakage current readings.

Further, the power system, the meter and personnel are thoroughly protected by a series of switches and shorting means that insure a continuous ground to the ground terminal of the arrester protecting the system, bypass and multiplying switches for the meter as well as surge current cutout means connected across the meter, and interlock grounding means for the safety of personnel working on the instrument.

What is claimed is:

1. A test set for monitoring the condition of a lightning arrester connected in service over the life time of the arrester, said arrester including an opaque insulating housing containing a circuit comprising at least one spark gap and at least one nonlinear resistance capable of conducting discharge and leakage currents, said test set comprising:

arrester duty determining means connected in series with the circuit of said arrester, said means including replaceable spark gap means capable of conducting the discharge currents, said spark gap means having electrodes capable of being visually inspected to thereby provide a visual indication of the nature and character of the discharge currents conducted by the arrester,

said spark gap means comprising at least two spark gap devices one of said devices being a replica of the spark gap contained within said opaque housing, the other of said devices being a mirror gap device capable of being particularly marked by the discharge currents,

a metering means connected in series with the circuit of said arrester for measuring the leakage current and for indicating changes in leakage current over a period of time, and

a separate housing structure for housing said arrester duty determining means and said leakage current measuring means.

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