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LIGHTNING ARRESTER LEAKAGE CURRENT AND DUTY MONITORING SYSTEM

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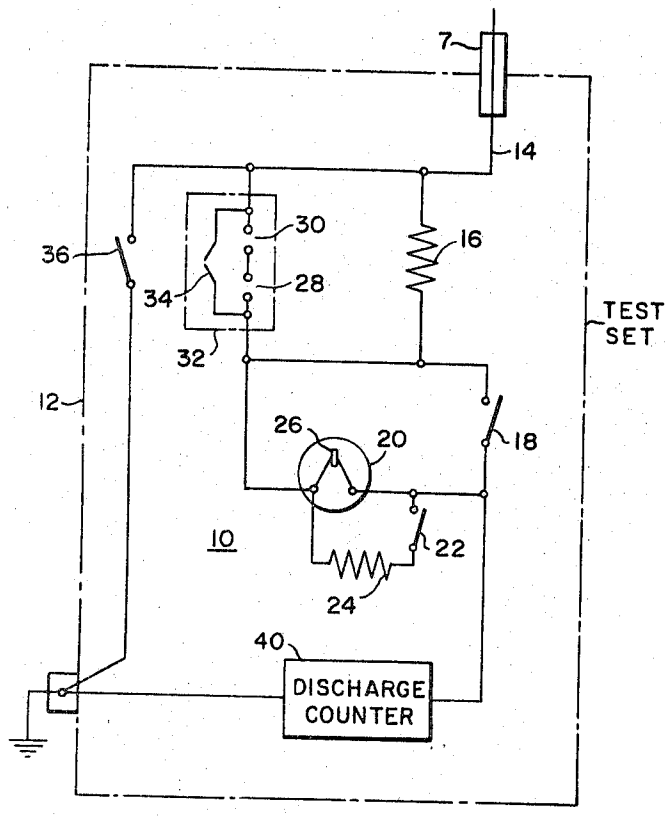

FIG. 1.

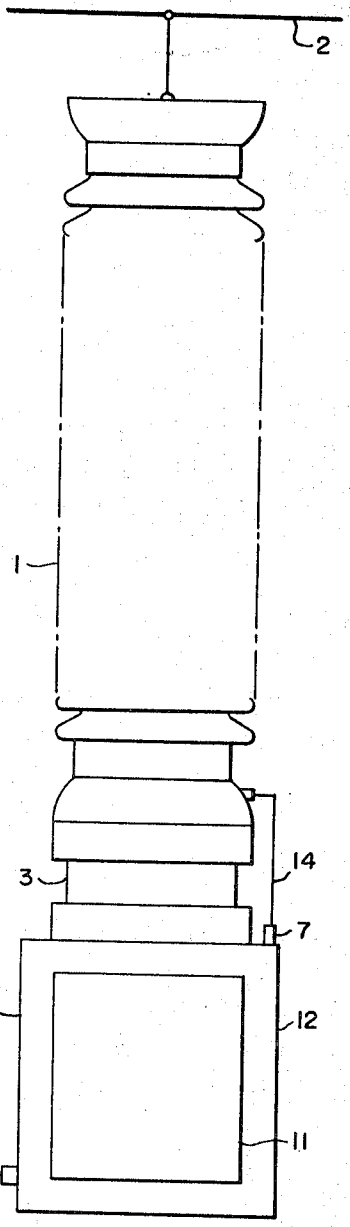

FIG. 2.

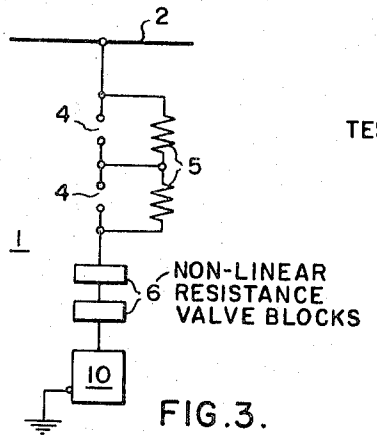

FIG. 3.

WITNESSES

Edwin E. Barnes

Elroy Strickland

INVENTOR

Richard E. Kennon

BY J. P. Lyle

ATTORNEY

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LIGHTNING ARRESTER LEAKAGE CURRENT AND DUTY MONITORING SYSTEM

Richard E. Kennon, Bloomington, Ind., assignor to Westinghouse Electric Corporation, Pittsburgh, Pa., a corporation of Pennsylvania

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U.S. Cl. 324—72 1 Claim

ABSTRACT OF THE DISCLOSURE

A test set or instrument package for monitoring the condition of a lightning arrester while connected in service over the life time of the arrester comprising spark gap means for indicating the discharge duty experienced by the arrester and a metering means for indicating arrester leakage current, both of said means being connected in series in the circuit of the arrester.

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 operations it must perform. Ordinarily, the arrester stands by with 60-cycle voltage impressed across its terminals. At some time which the arrester cannot foresee, a transient voltage appears at its terminals. If it is high enough, the arrester operates and surge current flows through the arrester to 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 semiconducting 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.

Thus arrester leakage current generally consists of grading and contamination current, and a measure of these currents can give an indication of the internal conditions of arrester components (grading current) and the extent to which contaminating substances are deposited on the surface of the arrester housing (contamination current).

Heretofore buyers and users of arresters could not conveniently and efficiently determine the working condition of and the duty imposed on arresters after they had been placed in service. Usually, the arrester units have to be tested for these things in the manufacturer's factory after the units are removed from service and transported to the factory or test area. There the arresters are examined and tested with an instrument in which a relatively high voltage is applied across each arrester. This procedure is obviously troublesome and inefficient since the times and places for testing are arbitrary and uncertain; arrester testing should be easily accomplished at any time desired in order to effect proper preventive maintenance programs and repair and replacement techniques. Further, leakage current readings and duty test measurements are more reliable when made at a voltage level near the normal working voltage of the system in which the arresters are used.

Therefore the principal object of the present invention is to provide a unique, effective and efficient means for monitoring lightning arresters while they remain in service in the system in which they are provided to protect.

Another object of the invention is to provide a simple and inexpensive means for accurately metering arrester leakage current and duty conditions.

Yet another object of the invention is to provide a novel means for testing the internal and external conditions of arresters at any time.

In general these and other objects of the invention are accomplished by providing a unique combination of parts and components housed in an enclosure to form essentially a unitary test set structure easily combined with a lightning arrester device. The combination includes a meter permanently disposed in the test set housing for connection in the ground circuit of an arrester device. The meter is ordinarily short circuit by a by-pass switch located in or on the housing. The switch is opened when it is desired to take readings of arrester leakage current. In addition, there is disposed in the housing for electrical connection in the ground circuit of an arrester device, a mirror gap and a discharge counting means connected in series with each other and in series between the arrester and ground. These means are utilized to determine the duty seen by the arrester device. By visual inspection of the mirror gap means it is possible to determine the character and duration of surge currents passed by the arrester. In a similar manner, all to be more fully explained hereinafter, a replica gap can be included in the ground circuit of an arrester and physically disposed within the housing that encloses the test set components. The replica gap is a duplicate of the arrester spark gaps and thus sees the same duty. The condition of the replica gap will therefore be the condition of the spark gaps contained in the arrester, and a visual inspection of the replica gap will give a ready indication of the condition of the arrester spark gaps. Thus, the unique combination of the above named components connected in the ground circuit of an arrester provides a novel means and method for quickly and effectively determining the complete condition of the arrester connected in service without necessitating removal of the arrester from service. Further, there is included within the housing an interlock switch means that grounds the input terminal to the test set whenever a panel assembly is opened for purposes of maintenance and repair. All internal components are grounded and re-

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 lightning 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 millimmeter such as used in the device shown and described in copending application 485,295 filed September 7, 1965, by John B. Brittain and and Edward F. W. Beck and assigned to the present assignee. A multipler 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 gap **28** (along with gap means **30**) may be disposed in or form a part of a gap subassembly generally designated by dash line encolsure **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 in 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 about .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 impedance means and a parallel connected capacitor designed to receive the surve 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 **12** 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 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 **1**. Arrester **1** is secured to the top of instrument cabinet **12** and may be insulated therefrom by an insulating base or separator **3**. 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 **1** in FIG. 2. Gaps **4** may be capacitance graded or they may be both capacitance and resistance graded. 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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RUDOLPH V. ROLINEC, *Primary Examiner.*

E. L. STALARUN, *Assistant Examiner.*

U.S. Cl. X. R.

317—61, 70; 324—54