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METHOD OF DETERMINING LEAKS IN LIGHTNING ARRESTERS AND THE LIKE

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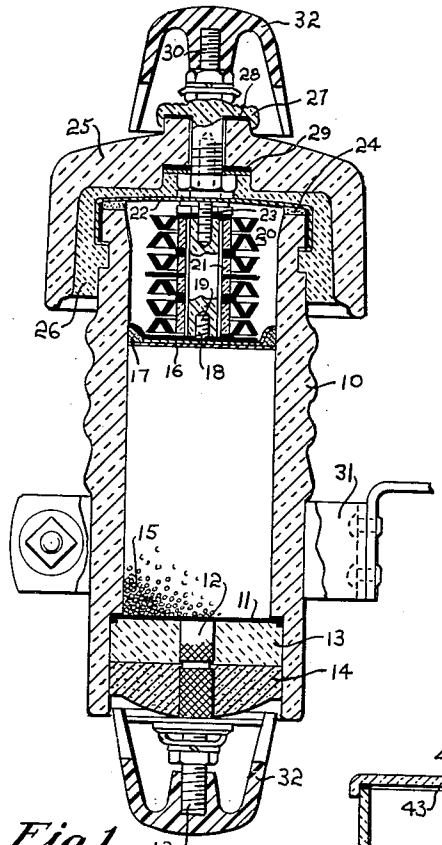



Fig. 1.

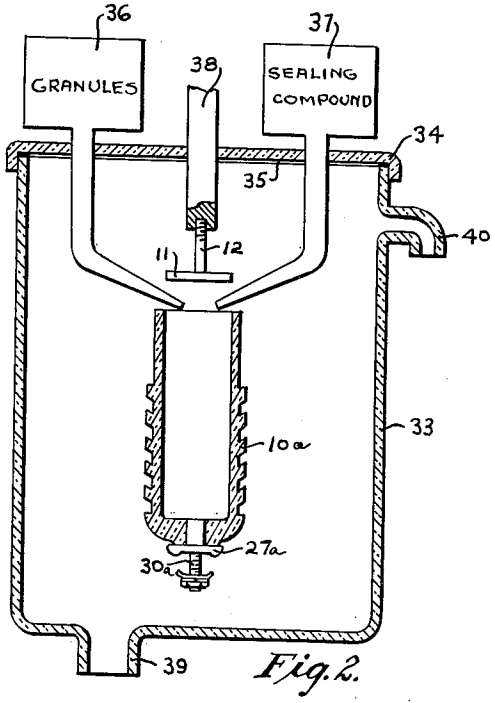



Fig. 2.

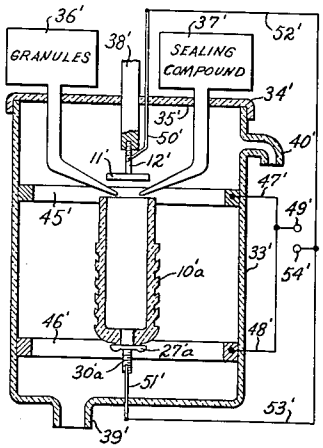



Fig 4.

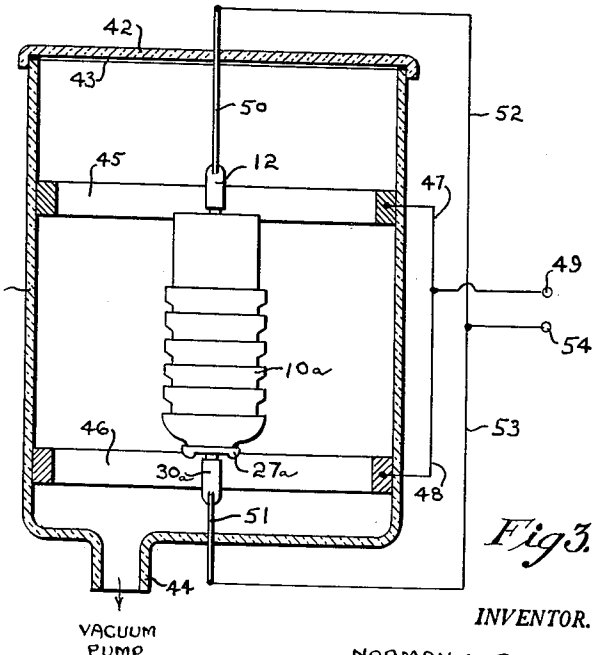



Fig 3.

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# METHOD OF DETERMINING LEAKS IN LIGHTNING ARRESTERS AND THE LIKE

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This invention relates to a method of testing for leaks in any vessel having an interior volume which it is desired to maintain sealed off from communication with an external ambient atmosphere. More particularly, this invention relates to a method of leak-testing lightning arresters, either after the completion of the manufacturing thereof or at some later time.

The purpose of sealing the interior of a lightning arrester from its surrounding environment is to prevent the entry of moisture or other substances which interfere with the proper functioning of the spark gap structure or the potential barrier material housed within the lightning arrester and by means of which a designed for lightning arrester breakdown potential is established.

It is known that moisture laden lightning arresters are not only the cause of radio disturbances but also that the presence of moisture within the arrester sooner or later results in the failure thereof, this failure being due to the fact that the moisture forms upon the spark gap electrodes electrically conductive salts of the metal of which the electrodes are made. Consequently, the gaps between the electrodes are substantially decreased if not entirely bridged. Moreover, in those types of lightning arrester employing crystalline conductive particles, or bonded conductive materials in the form of rods, plates or blocks, exhibiting the proper characteristics required for use in lightning arresters, the presence of moisture within the arrester eventually affects the characteristics of such elements to such an extent as to interfere with the normal operation of the lightning arrester, if not rendering it wholly inoperative.

The operating characteristics of the lightning arrester are adversely affected by the establishment of electrically conductive current leakage paths by means of which current flow through the lightning arrester takes place even under circumstances in which the lightning arrester should appear as an open circuit. The leakage paths through the lightning arrester give rise to radio interference signals and also render the lightning arrester incapable of performing with maximum efficiency, in some extreme cases even causing fused circuits to be open circuited by blowing the fuses or opening circuit breakers associated therewith. The importance of maintaining the interior of the lightning arrester effectively isolated from its surrounding external atmosphere is therefore readily understandable. Accordingly, it is a primary object of this invention to provide a novel method of testing lightning arresters or other sealed vessels to determine whether or not a complete seal has been effected during manufacture and to thereby avoid faulty operation and premature failure of the lightning arrester when installed for operation in the field.

Another object of the invention is to provide a novel method of determining the presence of leaks in a supposedly sealed vessel by first carrying out the sealing process in an inert gas atmosphere and then subjecting the sealed vessel to an electrostatic field of sufficient strength to produce a visible glow discharge in the event that the inert gas issues out of the supposedly sealed vessel due to the existence of an incomplete seal.

Yet another object of this invention is to provide a novel method of detecting the presence of leaks in supposedly sealed vessels by first carrying out the sealing



of the vessel in an atmosphere of an inert gas and then subjecting the sealed vessel to an atmosphere of substantially reduced pressure while simultaneously applying a strong electrostatic field thereto, the reduced pressure atmosphere causing the inert gas sealed within the vessel to be accelerated in its outward flow through any non-sealed openings and so resulting in a material decrease in the time required to test a particular unit.

Still another object of the invention is to provide a novel method of determining the presence of leaks in supposedly sealed containers which method does not require the use of the usually employed and very expensive mass spectrometer apparatus, but which rather utilizes a relatively inexpensive vacuum chamber form of apparatus by reason of which the incremental cost assignable to any particular tested unit may be kept very small.

The foregoing and other objects of the invention will become clear from a reading of the following specification in conjunction with an examination of the appended drawings, wherein:

FIGURE 1 is a longitudinal sectional view through a typical lightning arrester such as could be tested according to the method of the invention;

FIGURE 2 is an illustration in diagrammatic form of an empty lightning arrester body positioned within a chamber whose atmosphere may be controlled by charging and flushing with various gases, and also illustrates in schematic form means for fabricating and sealing the lightning arrester;

FIGURE 3 illustrates, also in schematic form, a completed lightning arrester positioned within a vacuum chamber and means for testing the same for the presence of leaks; and

FIGURE 4 illustrates a combination of the structures of FIGURES 2 and 3 for effecting fabrication and testing of lightning arresters in one chamber.

In the several figures like elements are denoted by like reference characters.

Referring now to the figures and firstly to FIGURE 1, it will be observed that the illustrated typical lightning arrester comprises a non-conducting substantially cylindrical casing or main body portion **10**, preferably of porcelain, into the lower end of which is fitted a grounding assembly consisting of the metallic plate **11** and terminal stud **12**, the entire assembly being held in place by the sealing compound **13** and cement **14**. Filling a substantial portion of the casing **10** and in electrical contact with the metallic plate **11** is a discrete mass of crystalline conducting granules **15** such as silicon carbide crystals. This granular mass of conducting material is confined within the casing **10** by an upper metallic plate **16** peripherally sealed to the interior surface of the wall of the body portion **10** by means of the cement ring **17**, the plate **16** having a centrally located vertically upwardly extending threaded stud **18** affixed thereto. The stud **18** is threaded into the lower end of an insulator rod **19** upon which is disposed a plurality of vertically spaced pairs of dished spark gap electrodes **20**, each pair of electrodes being maintained in a predeterminedly spaced relation by the insulator spacers **21**.

The upper end of the casing **10** is closed by a metal closure cap **22** sealed thereto by an annular layer of cement **24** and having centrally secured thereto a downwardly projecting threaded stud **23** which is threaded into the upper end of the insulator rod **19**. The stud **23** is part of a central terminal assembly which extends upward through a porcelain insulator fitting **27** and terminates in a terminal portion **30**. The arrester is completed by the insulator porcelain cap **25** secured physically in place between the gaskets **28** and **29** by the fitting **27** and having its interior filled with sealing compound **26** which completely fills the space between the inside of the cap

25 and the closure cap 22 together with its associated central terminal assembly, the sealing compound 26 extending downwardly below the bottom edge of the closure cap 22 for some distance along the outer surface of the main body portion 10 of the lightning arrester. A mounting bracket 3 and a pair of opposite end terminal insulating covers 32 complete the lightning arrester assembly.

Barring flaws or cracks in the casing 10, it will be observed from the showing of FIGURE 1 that the casing interior containing the granules 15 and the spark gap electrode structures 20 is completely sealed away from the lightning arrester ambient atmosphere by the sealing compound 13 and cement 14 at the lower end of the lightning arrester, and by the sealing compound 26 and cement 24 at the upper end of the lightning arrester. While cracks in the casing 10 are fairly readily detected, voids or flaws in the closures provided by the sealing compound and cement layers can easily go undetected and as a consequence lightning arresters may be placed in use which are in fact not completely sealed, and which are, therefore, subject to faulty operation and premature failure due to the entry of moisture as already previously described. It is the detection of these normally unnoticed sealing imperfections with which this invention is concerned and which will now be described in conjunction with the showings of FIGURES 2 and 3 of the drawings.

Considering first the showing of FIGURE 2, there will be seen a vessel 33 having a top closure plate 34 sealingly engaged with the vessel 33 by means of a gasket 35 and through which are downwardly extended into the interior of the vessel 33 a pair of feeder devices 36 and 37 and a means 38 for inserting and positioning into the body 10*a* of the lightning arrester the metallic plate 11 and attached terminal stud 12. The lightning arrester, which is diagrammatically shown in FIGURES 2 and 3, may be of any type and may or may not be provided with fittings 27*a* and 30*a* such as those of the arrester shown in FIGURE 1. The feeder device 36 may be adapted to fill the body of the lightning arrester with the silicone carbide granules, and the feeder device 37 may be adapted to flow the sealing compound 13 (as shown in FIGURE 1) into the end of the body of the lightning arrester after the positioning means 38 has inserted the bottom terminal assembly thereinto.

Of course, the feeder devices 36 and 37 and the insertion means 38 are properly sealed where they pass through the top closure plate 34 (by means not shown) to insure that the interior of the vessel 33 is maintained in isolation from the outside atmosphere. Similarly, the lightning arrester is held in proper position within the vessel 33 by means also not shown and which may constitute any suitable apparatus such as a clamp or other device.

The vessel 33 is provided with a bottom fitting 39 and a side fitting 40, one of which may be considered an inlet and the other an outlet, by means of which the vessel 33 may be placed in a closed gas circuit with apparatus for flushing and charging the interior of the vessel 33 with a desired gas or combination of gases to provide an artificial atmosphere for the assembling of the lightning arrester. In general, it is contemplated that a chemically inert gas or combination of such gases would be employed, as for example neon, argon, krypton, or xenon. The foregoing gases are particularly suitable for use because being chemically inert they will not combine with or otherwise contaminate the substances from which the lightning arrester is made, and additionally pprovide the means for producing characteristically colored glow discharge when subjected to an electrostatic field of sufficient strength.

Thus, when a lightning arrester is assembled in the vessel 33 in an atmosphere of argon for example, the argon molecules will permeate the interior of the lightning arrester casing 10 and replace the air which would normally be there but which has been removed by the flushing operation. The finished lightning arrester will then, of course, have an internal volume of argon gas instead of air so that any leaks occasioned by imperfect sealing of the ends of the lightning arrester will allow the argon gas to escape thereoutof, and when subjected to an electrostatic field of proper strength will produce a visible violet glow in the region of the leak. Of course, should a perfect seal have been effected then there will appear no characteristic glow since the argon gas will be wholly contained within the body of the lightning arrester, having no means for egress therefrom.

One form of testing apparatus for applying the requisite electrostatic field to the finished lightning arrester is illustrated in the showing of FIGURE 3, to which attention should be now directed. In FIGURE 3 there is seen a transparent vacuum chamber 41 closed at the top by a cover plate 42 peripherally sealed to the chamber by a gasket 43. The bottom of the chamber is provided with a fitting 44 by means of which a vacuum pump (not shown) may be connected to the vacuum chamber 41. Secured to the inside surface of the vacuum chamber walls are a pair of peripherally extending electrical conductor bands 45 and 46 electrically connected together by the external leads 47 and 48 which pass through the wall of the vacuum chamber 41 for connection to the conductors 45 and 46 and which are externally connected to one terminal 49 of a source of electrical potential.

The lightning arrester itself is positoned within the chamber 4 as illustrated and electrical connections are made to the arrester terminals 12 and 30 by means of the supporting electrodes 50 and 51 respectively which pass through the top and bottom of the vacuum chamber and are connected together by the external leads 52 and 53, which in turn are connected to the other terminal 54 of the electrical potential source. It will be noted that the conductor bands 45 and 46 are spaced apart the proper distance to place them in the immediate regions of the ends of the lightning arrester body portion 10 since these are the points at which the leaks, if any, will occur.

In operation, a high electrostatic potential is applied to the terminals 49 and 54 so that an electric field is established between the leads 50 and 51 on the one hand acting as a common electrode and the conductor bands 45 and 46 on the other hand acting as the opposite electrode. The internal atmosphere of the vacuum chamber 41 is then exhausted by means of the vacuum pump so that the pressure therein drops to an absolute pressure of approximately twenty millimeters of mercury or less. If a leak exists due to imperfect sealing of the ends of the lightning arrester, the gas contained within the lightning arrested body at approximately normal atmospheric pressure will tend to flow outward through such leaks and into the substantially reduced pressure zone of the vacuum chamber interior.

As the gas issues from the leak, it emerges into a region between the lightning arrester terminal 12 and conducting band 45 or the region between the lightning arrester terminal 30 and the conductor band 46. Since both of these regions are precisely the regions of maximum electric field a glow discharge takes place in the well-known fashion due to excitation of the electron shells of the gas atoms attended by the release of quanta of light of a wave length characteristic of the particular gas employed. The glow discharge is, of course, immediately visible, it is known for a certainty that a leak exists, and the location of the leak is ascertained. The lightning arrester may then be removed and reprocessed and again tested until, under test conditions, the glow discharge is found to be absent. It follows, naturally, that a properly sealed lightning arrester will not even in the first instance exhibit the glow discharge and hence it will be known to be completely sealed and hence ready for use.

It should be borne in mind that the illustrated methods of assembling and testing the lightning arrester are only exemplary and that alternate systems of so doing may

be employed with equal success without departing basically from the concept of the invention. For example, it is possible that the filling and testing chambers illustrated in FIGURES 2 and 3 could be combined into a single chamber and the entire operation carried out therein without the need for transferring the lightning arrester from one chamber to another. Such an arrangement is shown in FIGURE 4 which is observed to be the physical structure of FIGURE 2 to which has been added the electrical testing aspects of FIGURE 3, corresponding parts to those of FIGURES 2 and 3 being similarly numbered and primed, as for example 45 and 45'. Also, although merely a single lightning arrester is illustrated in the figures as being assembled and tested, it is possible to fill a plurality of such arresters at the same time, and, moreover to simultaneously test such a plurality of lightning arresters. Finally, it will be understood that the particular structure illustrated as being tested, namely, a lightning arrester, is merely illustrative of the testing of any of a wide range of sealed vessels which may be completely dissimilar in shape or function but which neverthless are susceptible to testing by the method of the invention.

Accordingly, although the invention has been described in connection with a particularly illustrated embodiment thereof, it is to be understood that variations and modifications may now naturally occur from time to time to those persons normally skilled in the art without departing from the essential scope or spirit of the invention, and it is, therefore, intended to claim the same broadly as well as specifically as indicated by the appended claims.

What is claimed as new and useful is:

1. A method of testing for leaks a hollow container sealed in an inert gas atmosphere consisting of the steps of, placing the container to be tested into a vacuum chamber having a pair of spaced apart electrodes, said container being so placed within the chamber that the sealed region of the container lies substantially between the spaced electrodes, connecting the electrodes to a source of electric potential to thereby establish an electric field therebetween, and reducing the pressure in the vacuum chamber below the pressure at which the container was sealed, whereby if a leak exists in the container seal the inert gas within the container will flow outward therethrough into the electric field region of the vacuum chamber and emit a characteristically colored glow in the visible spectrum.

2. The method according to claim 1 wherein the step of reducing the pressure in the vacuum chamber below the pressure at which the container was sealed is continued until the vacuum chamber absolute pressure is equal to substantially not more than 20 millimeters of mercury.

3. A method of testing a hollow lightning arrester having a metallic terminal projecting outward through a layer of material applied in an inert gas atmosphere to seal the hollow interior of the arrester, including the steps of placing the lightning arrester to be tested into a vacuum chamber having a pair of spaced apart electrodes, connecting the arrester metallic terminal to one of the vacuum chamber electrodes, connecting the vacuum chamber electrodes to a source of electric potential to thereby establish an electric field therebetween, and reducing the pressure in the vacuum chamber below the pressure of the inert gas atmosphere in which the arrester was sealed, whereby if a leak exists in the arrester seal the inert gas within the arrester will flow outward therethrough into the electric field region of the vacuum chamber and emit a characteristically colored glow in the visible spectrum.

4. A method of excluding an undesirable atmosphere from the interior of a hollow container to be sealed and then testing the sealed container for leaks consisting of the steps of placing an open hollow container into a sealable vessel having means for inserting material into the vessel interior without breaking the sealed condition and including a pair of spaced apart electrodes, said container being so placed within the vessel that the container region to be sealed lies substantially between the spaced electrodes, sealing the vessel, charging and flushing the sealed vessel interior with an inert gas until substantially all of the previous atmosphere has been removed, and inserting sealing compound into the vessel interior to seal the hollow container placed therein so that the hollow interior of the sealed container contains an inert gas atmosphere non-communicative with the container ambient atmosphere, followed by the steps of flushing the sealed vessel of the inert gas atmosphere, connecting the electrodes to a source of electric potential to thereby establish an electric field therebetween, and reducing the pressure in the sealed vessel below the pressure at which the container was sealed, whereby if a leak exists in the container seal the inert gas within the container will flow outward therethrough into the electric field region of the sealed vessel and emit a characteristically colored glow in the visible spectrum.

5. The method according to claim 4 wherein the step of reducing the pressure in the sealed vessel below the pressure at which the container was sealed is continued until the vacuum chamber absolute pressure is equal to substantially not more than 20 millimeters of mercury.

6. The method according to claim 4 wherein prior to the step of inserting sealing compound into the sealed vessel interior to seal the hollow container placed therein, there is performed the step of depositing within the hollow container a substance desired to be sealed therewithin.

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