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PRESSURE RELIEF IN LIGHTNING ARRESTERS

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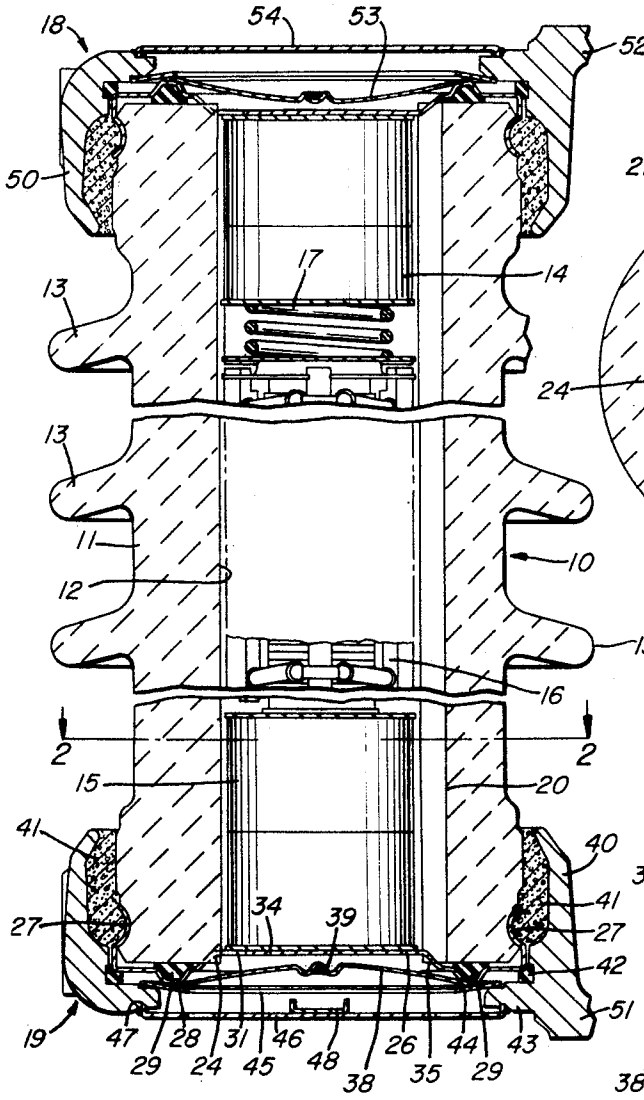


FIG. 1

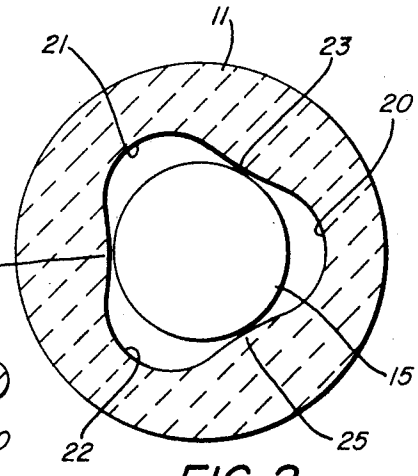


FIG. 2

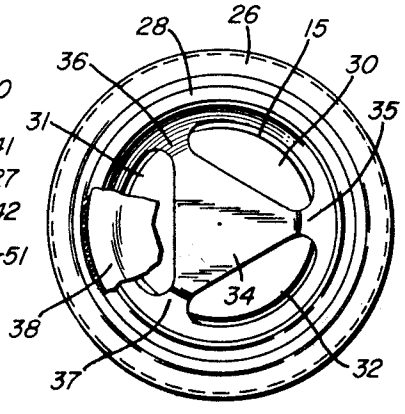


FIG. 3

INVENTOR.
JOHN W. KALB
JOHN J. TAYLOR
ARNOLD G. YOST

BY Kenneth W. Miller

ATTORNEY

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PRESSURE RELIEF IN LIGHTNING ARRESTERS

John W. Kalb, Wadsworth, John J. Taylor, Medina, and Arnold G. Yost, Barberton, Ohio, assignors to The Ohio Brass Company, Mansfield, Ohio, a corporation of New Jersey

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15 Claims. (Cl. 315—36)

This invention relates to electrical protective devices and more particularly to an improved over pressure relief arrangement for lightning arresters and the like.

In the operation of valve type lightning arresters, it is known that, upon failure of an arrester to interrupt the flow of follow current, a short circuit current flows through the arrester with a consequent overheating of the arrester elements and formation of short circuiting arcs therein. Such overheating and arcing results in the evolution of gases in the interior of the housing and since the arrester elements are ordinarily incorporated in a totally enclosed housing, there results a rapid increase in the pressure of the atmosphere within the housing at a rate determined by the magnitude of the short circuit current. The occurrence of such a condition results in an explosion of the arrester unless some means are utilized to prevent the formation of excessive pressures.

One such means is disclosed in U.S. Patent 2,640,096 issued May 26, 1953 to J. W. Kalb, wherein there is shown a lightning arrester construction in which a closure means at an end of the ceramic housing for the arrester incorporates a thin diaphragm. This diaphragm is adapted to rupture and provide an opening to the external atmosphere upon the development of excessive pressure within the arrester.

The results of considerable experience in connection with the development and manufacture of the lightning arresters of the above referenced Kalb patent have indicated that on certain occasions or under certain circumstances the operation of the over pressure relief means of that arrester is inconsistent with the observed facts. Thus, the over pressure relief means might function properly, e.g. the diaphragm rupture to discharge the gases, at short circuit currents in the order of 15,000 amperes and again be quite ineffective at short circuit currents of in the order of 5,000 amperes.

The present invention is concerned with improvements in lightning arrester constructions and over pressure relief apparatus effective to prevent pressure build-up in the internal atmosphere of lightning arresters, effective over a wide range of short circuit current magnitudes and durations.

In accordance with the invention, there is provided a lightning arrester housing in which a plurality of longitudinally extending grooves are incorporated in the inside wall of the housing. The housing is provided with metallic end pieces having large apertures for transmitting expanding gases from the interior of the housing and which also serve as supports for the arrester elements within the housing, the arrangement being such that the end pieces receive the end forces generated by relative longitudinal movement of the lightning arrester elements. Each end piece is covered by a thin metallic diaphragm which extends across the openings in the end piece and which is adapted to move outwardly and ultimately to rupture upon a sufficient increase in the pressure of the atmosphere within the housing.

Additionally, a base member which surrounds the lower

end of the housing in the end piece just referred to, is provided with a cover which is separably attached to the end piece so that when the diaphragm is forced outwardly the cover is driven from the end plate so that the gases may readily escape from the interior of the arrester housing. The entire arrangement of longitudinal grooves, the apertures and the end pieces and the disposition of a diaphragm cover is such that the very rapid evolution of gases from the arrester elements, such as is ordinarily produced by very high flow currents, is accommodated without pressure build-up within the housing itself. Additionally, however, a diaphragm piercing member is provided so that the diaphragm will be ruptured even though the movement of the diaphragm occurs only as the result of the development of only relative small pressure in the internal atmosphere of the arrester.

The invention will be more clearly understood by reference to the following specification and claims taken in connection with the appended drawings, in which

Fig. 1 is a vertical sectional view of an arrester constructed in accordance with the invention;

Fig. 2 is a sectional view showing the arrester housing and valve block taken in the direction 2—2 in Fig. 1; and

Fig. 3 is a bottom end view of the arrester of Fig. 1 with the base member removed and showing particularly the end piece construction.

Referring now to Fig. 1, the lightning arrester **10** includes a porcelain housing **11** comprising an elongated tubular member having an internal opening **12** and external flanges **13** for increasing the leakage distance along the external surface of the member. The housing **11** encloses a stack of arrester elements including valve blocks **14** and **15** and gap unit **16** with a spring **17** for maintaining the arrester elements in stacked relation and the end valve blocks in contact with the supporting elements of the closure means **18** and **19**. The closure means **18** and **19** close the ends of the housing and also function as base members for the lightning arrester and as terminals for the arrester elements **14**, **15** and **16**.

The arrester elements function in a known manner, the gap unit serving to establish a conductive path from an external conductor through the valve blocks to ground upon the occurrence of a sufficient over voltage. However, the valve blocks and gap unit are designed to accommodate certain magnitudes of discharge currents, so that, when those current magnitudes are exceeded, arcing takes place within and between the elements of the arrester. Such arcing is accompanied by the evolution of gases from the arcing portion of the arrester elements and the pressure within the arrester housing increases rapidly according to the strength of the arcing.

We have found that the evolution of gases by the valve blocks and gap unit is liable to occur with greater intensity at certain portions of the arrester element column than at others and that, in general, a much greater accommodation for discharge of the gases from the center part to the ends of the housing is necessary than had heretofore been utilized. Accordingly, as shown particularly in Fig. 2, the housing **11** has the inside portions of the walls formed with generally triangularly disposed grooves **20**, **21** and **22** extending radially outward from the inwardly directed portions **23**, **24** and **25** which define what would otherwise be a cylindrical opening in the housing. The inwardly directed portions **23**, **24** and **25** serve to restrain and hold the arrester elements **14**, **15** and **16**. It can be seen that by the use of the construction as shown in Fig. 2, substantial quantities of gas may be readily carried to the ends of the housing whatever the position along the arrester stack at which the evolution of gas may take place, and that relatively large quantities of gases may be discharged.

Referring again to Fig. 1, the closure means **19** in-

cludes an end piece 26 which extends across the lower extremity of the housing 11. A portion 27 of the end piece extends upward along the outside of the wall of the housing and is spun into engagement with a groove in the wall in order to provide a firm joint. The end piece 26 has a circumferential groove 28 formed in the piece with a sufficient radius such that the groove is disposed between the outer extremity of the grooves 20, 21 and 22 and the outside wall of the housing. The groove 28 of the end piece receives a gasket 29 which contacts the end of the housing 11 and seals the periphery of the end piece with respect to the housing.

As shown also in Fig. 3, the end piece 26 is formed with three circumferentially disposed openings 30, 31 and 32, an inwardly deformed central part 34, and the parts 35, 36 and 37 between the openings integrally connecting the central part with the peripheral part of the end piece. The end piece 26 and the housing 11 are assembled with the parts 35, 36 and 37 received in the grooves 20, 21 and 22 and the projecting portions 23, 24 and 25 of the housing received in the openings 30, 31 and 32 of the end piece. Thus, as shown in Fig. 1, the portion 35 of the end piece 26 is received in the groove 20 while the projection 24 between the grooves 21 and 22 is received in the opening 31 of the end piece 26. With this arrangement, the central part 34 of the end piece 26 may project generally upward into the interior of the opening 12 to support the stack of arrester elements while permitting free flow of gases about the end of the lowermost valve block and through the openings 30, 31 and 32 of the end piece 26.

As shown in Fig. 1, and fragmentarily in Fig. 3, a diaphragm 38 extends across the end piece 26 opposite the openings 30, 31 and 32 and is brazed or otherwise attached to the exterior of the groove 28. The diaphragm 38 is domed upwardly into the space provided by the elevated central part 34 of the end piece 26 and is crowned, as indicated at 39, to prevent flexing and metallic fatigue due to such changes as may be produced by variations in atmospheric temperature and pressure. The diaphragm is formed of thin copper in order to facilitate rupture and relief of excessive internal pressures, and may be in the order of five mils in thickness. These and other considerations are set forth in U.S. Patent 2,640,096 to which reference has been made.

The interior of the arrester is evacuated and filled with nitrogen through a small opening in the crown 39 of the diaphragm after which the opening is sealed with solder.

Surrounding the lower end of the housing 11 and the end piece 26 is a base member 40 which extends upwardly beyond the part 27 of the end piece 26 and along the outside of the enlarged end of the housing. The space between the base member 40 of the housing 11 and portion 25 is filled with a hardened cement body 41 to anchor the base member to the housing. An annular gasket 42 between the base member 40 and the peripheral corner of the end piece 26 seals and separates the cement containing space from the space between the base member and the diaphragm.

The base member 40 has an annular inwardly projecting part 43 disposed below the end piece 26 with an inward extent or diameter somewhat greater than the outward extent or diameter of the groove 28 of the end piece 26. A spring piece 44 is received between the groove 28 of the end piece 26 and the interior part of the annular part 43 of the base member in such a way that the piece 44 is deformed into a generally frustroconical shape and thereby maintains a constant pressure upon the end piece 26.

The spring piece 44 is formed with an interior opening 45 which extends radially outward substantially to the junction of the diaphragm 38 with the groove 28 of the end piece 26. This arrangement permits the diaphragm to move freely downward and through the opening 45,

as well as permitting the initial rapid expansion and free flow of the gases from the housing.

The base member 40 is provided with a cover 46 which extends entirely across the open end of the member, e.g. the opening defined by the part 43. The cover 46 has the periphery received in a groove 47 and is soldered or otherwise suitably fastened to the base member 40. A member 48 having inwardly directed pointed ends is fastened to the inside of the cover 46, the pointed end part serving to pierce the diaphragm 38 when the diaphragm is moved outwardly under the force of the internal pressure generated by the expanding gases.

The closure means 18 at the upper end of the arrester is constructed in the same manner as the closure means 19 at the lower end of the arrester just described, with the exception that the diaphragm piercing member 48 is omitted.

The base members 40 and 50 incorporate radially extending flanges, such as the flanges fragmentarily shown at 51 and 52 for mounting the arrester.

In operation, an arrester such as the arrester 10 of Fig. 1 ordinarily operates without the generation of any gases within the interior of the housing. However, upon the occurrence of an overload or other circumstances, causing the blocks to lose their current limiting characteristic, results in a failure of the valve blocks and the formation of arcs within the housing. Such arcs cause the evolution of large quantities of gas with a consequent rapid build-up of pressure within the arrester. The gas so evolved flows through the grooves 20, 21 and 22 to the ends of the arrester, causing the deformation and outward movement of the diaphragms 38 and 53. Since, in this circumstance, the build-up is very rapid, the piercing of the diaphragm 38 by the prongs of the member 48 is of little effect and either or both of the covers 46 and 54 are blown off and the gases freely discharged to the outside atmosphere. This mode of operation occurs in high fault current locations where the short circuit currents, referred to above, are of very large magnitudes and hence generate gases at a very rapid rate. It is apparent that the grooves 20, 21 and 22 have an important effect upon the discharge of the gases under such circumstances.

The pressure relief arrangement shown is equally useful in circumstances in which relatively low short circuit currents or currents of a relatively short duration are produced by failure of an arrester element. If, under such conditions, the accumulation of gases within the arrester housing is terminated at relatively low pressures, say in the order of several atmospheres, the pressure relief arrangements in prior practice did not function to discharge the accumulated gases into the external atmosphere.

In the present arrangement, however, the development of gas pressures within the housing, even at very low pressures and rates of generation, causes the diaphragm 38 to move outwardly so that the prongs of the member 48 pierce the diaphragm and allow the accumulated gases to escape through the openings 53 in the cover 46. As a result, the possibility of injuries to technical personnel working with an arrester in which such over pressures have been formed is obviated.

It is to be understood that the foregoing description is not intended to restrict the scope of the invention and that various rearrangements of the parts and modifications of the design may be resorted to. The following claims are directed to combinations or elements which embody the invention or inventions of this application.

We claim:

1. A protective device comprising a housing of rigid insulating material having a tubular wall and a longitudinal opening, a plurality of generally cylindrical arrester elements within the opening, and means normally closing the interior of the housing including a metal end

piece disposed transversely across an end of the housing for supporting the endmost arrester element, a groove in the inside wall of the housing extending longitudinally of the housing along the arrester elements to the said end of the housing and an opening in the end piece at least as large in cross section as the groove, all for directing gas flow from the vicinity of the arrester elements longitudinally of the housing and through the end piece, a thin circular domed metallic diaphragm attached to the end piece exteriorly thereof beyond the opening for normally closing the interior of the housing and the end piece, a metal base member surrounding the housing and end piece and projecting radially inward generally to the extremity of the diaphragm, sealing means between the base member and the housing for securing the base member to the housing, means holding the end piece relative to the housing and a separable cover exteriorly attached to the base member opposite the diaphragm all for release of accumulated gases upon a sufficient increase in pressure thereof.

2. The invention in accordance with claim 1 with a second similar end piece, diaphragm, base member, and sealing means at the remaining end of the housing and with the groove extending longitudinally through the housing and opening at both ends for facilitating discharge of gases from the central part of the arrester housing.

3. The invention in accordance with claim 1 and including a rupturing member supported by the base member on the interior thereof having at least a pointed part directed toward the diaphragm for piercing the diaphragm upon movement thereof under relatively low pressure and openings in the cover for relief of gases to the external atmosphere.

4. A protective device comprising a housing of rigid insulating material having a tubular wall and a longitudinal through opening, closure means at one end of the housing comprising a metal end piece disposed transversely across the end of the housing and having an annular outwardly recessed groove opposite the end of the wall of the housing, a gasket received in the groove and in contact with the end of the wall of the housing for sealing the interior of the housing, openings longitudinally through the end piece affording a path for gas flow through the end piece, a thin circular inwardly domed metallic piece attached to the end piece exteriorly thereof along the recessed part of the end piece for normally closing the interior of the housing and the end piece, a metal base member surrounding the housing and end part and projecting radially inward a distance less than the thickness of the wall of the housing beyond the end of the housing and end piece, a flat annular spring member disposed between the recessed part of the end piece and the base member and deformed into a frustro-conical shape to exert a compressive force upon the end piece and having a central opening opposite the domed piece greater than the transverse extent of the longitudinal opening of the housing, and a metal cover separably attached to the base member about the periphery thereof and having a transverse extent greater than that of the opening in the housing and the opening in the spring piece and a body of cementitious material between the base member and the housing for securing the base member to the housing, a second similar closure means at the remaining end of the housing and a body of cementitious material therefor, and a groove in the inside wall of the housing extending radially outward from the longitudinal opening thereof and extending longitudinally from end to end of the housing for facilitating gas flow from the central part of the housing to the ends thereof and the openings in the end pieces being arranged opposite the ends of the groove and having a transverse extent at least as great as that of the groove.

5. The invention in accordance with claim 4 and including a member attached to the cover on the inside thereof with a pointed portion directed toward the diaphragm for piercing the diaphragm upon outward movement thereof and openings in the cover for relief of gases to the external atmosphere.

6. A lightning arrester having a housing of rigid insulating material with a tubular wall and an axial opening and a stack of arrester elements including at least a valve block and a spark gap with means for maintaining the elements in stacked relation and base members at each end of the housing secured thereto, combined closure means and over pressure relief means which include, in combination, a plurality of symmetrically arranged grooves in the inside wall of the housing for facilitating gas flow from the central part of the housing to the ends thereof with intervening inwardly projecting parts for limiting transverse movement of the said arrester elements, an end piece disposed generally across the end of the housing and means sealingly engaged therewith and with the housing, the end piece having a plurality of circumferentially disposed openings with an inwardly depressed central part, the central part of the end piece projecting into the opening and supporting the arrester elements with the inwardly disposed parts of the housing projecting into the openings in the end piece and the portions of the end piece between the central part and the periphery of the end piece disposed in the grooves in the housing, and a thin inwardly directed metallic diaphragm attached to the end piece exteriorly thereof beyond the openings in the end piece for normally closing the interior of the housing and the end piece.

7. In a lightning arrester having a housing of rigid insulating material with a tubular wall and an axial opening and a stack of arrester elements including at least a valve block and a spark gap with means for maintaining the elements in stacked relation and base members at each end of the housing secured thereto, combined closure means and over pressure relief means which include, in combination, a plurality of symmetrically arranged grooves in the inside wall of the housing for facilitating gas flow from the central part of the housing to the ends thereof with intervening inwardly projecting parts for limiting the transverse movement of the arrester elements, an end piece disposed generally across the end of the housing, the end piece having a plurality of circumferentially disposed openings with an inwardly depressed central part, the central part of the end piece projecting into the axial opening of the housing and supporting the arrester elements and with the inwardly disposed parts of the housing projecting into the openings in the end piece and the portions of the end piece between the central part and the periphery of the end piece disposed in the grooves in the housing, a thin inwardly directed metallic diaphragm attached to the end piece exteriorly thereof radially beyond the openings in the end piece for normally closing the interior of the housing and the end piece, and a flat annular spring member received between the end piece and the base member in compressive relation with respect thereto for maintaining a pressure upon the end piece, the spring member having a central opening substantially equal in transverse extent to the diaphragm to permit outward movement of the diaphragm and rupture thereof upon an increase in pressure within the housing.

8. The invention in accordance with claim 7 and including a cover separably attached to the base member beyond the spring member and opposite the diaphragm and having a transverse extent at least equal to that of the opening in the spring member.

9. The invention in accordance with claim 8 and including a fixedly supported rupturing member with a pointed portion directed toward the diaphragm for piercing the diaphragm upon outward movement thereof and

openings in the cover for relief of gases to the external atmosphere.

10. An improved end construction for a protective device having a housing of rigid insulating material with a tubular wall and a longitudinal axial opening, comprising a metal end piece disposed transversely across the end of the housing and having a circular outwardly recessed part opposite the end of the wall of the housing, a plurality of peripherally disposed openings in the end piece inwardly of the said recessed part, all affording a path for gas flow through the end piece, a thin circular inwardly domed diaphragm attached to the end piece exteriorly thereof along the recessed part of the end piece for normally closing the interior of the housing and the end piece, a metal base member surrounding the housing and end part and projecting radially inward beyond the end of the housing and the end piece, and a flat annular spring member disposed between the recessed part of the end piece and the base member and deformed into a frusto-conical shape to exert a compressive force upon the end piece, and the said spring member and the said base member each having a central opening opposite the diaphragm substantially equal the transverse extent thereof.

11. The invention in accordance with claim 10 in which a separate cover is releasably attached about the periphery thereof to the exterior of the base member.

12. The invention in accordance with claim 11, in which a member, with an elongate part thereof directed toward the diaphragm, is carried on the interior of the cover for rupturing the diaphragm, and openings in the cover for relief of gases to the external atmosphere.

13. A protective device which includes a housing of rigid insulating material having a longitudinal opening therein, a stack of arrester elements in the opening, and means at one end of the housing closing the interior of the housing including a metallic diaphragm with means attached to the housing for carrying the diaphragm and the said diaphragm being adapted to rupture for discharge of gases evolved by the said arrester elements upon fault thereof, the said arrester housing comprising a generally tubular part extending inwardly at discrete portions thereof to adjacent the said stack and having an intermediate portion spaced from the stack in a radially outward direction to constitute a groove extending along the said stack to the said end of the housing for facilitating movement of gases from arrester elements distant from the said end of the housing to the end of the housing for discharge thereof.

14. In a protective device which includes elements capable of evolving gases under overload conditions, a sealed housing of rigid insulating material having a generally tubular wall, an open interior, and an open end for enclosing the said elements, means closing the end of the said housing including a thin metallic diaphragm extending transversely across the open end thereof, and means attached to the housing for carrying the diaphragm in sealed relation thereto, a rupturing device comprising a member having an elongate part thereof directed toward the diaphragm, and means fixedly supporting the said member exteriorly of the housing and of the diaphragm with the diaphragm normally spaced from the said member and movable into engagement therewith upon a predetermined increase of the pressure in the interior of the housing for penetrating the diaphragm.

15. In a protective device which includes elements capable of evolving gases under overload conditions, a sealed housing of rigid insulating material having a generally tubular wall, an open interior, and an open end for enclosing the said elements, means closing the end of the said housing including a thin metallic diaphragm extending transversely across the open end thereof, and means attached to the housing for carrying the diaphragm in sealed relation thereto, the said diaphragm being bonded to the said carrying means about the periphery thereof and normally domed toward the housing in a first position thereof and movable outwardly away from the housing under the influence of excessive pressures within the housing, a rupturing device comprising a member having an elongate part thereof directed toward the diaphragm, and means fixedly supporting the said member from the housing exteriorly of the housing and of the diaphragm, the diaphgram being spaced from the said member in the said first position thereof and movable into engagement with the member upon a predetermined increase of the pressure in the interior of the housing for penetrating the diaphragm.

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