Feb. 4, 1936. R. H. EARLE 2,029,562

PROTECTIVE DEVICE

Filed Feb. 27, 1933 2 Sheets-Sheet 1

Fig. 1

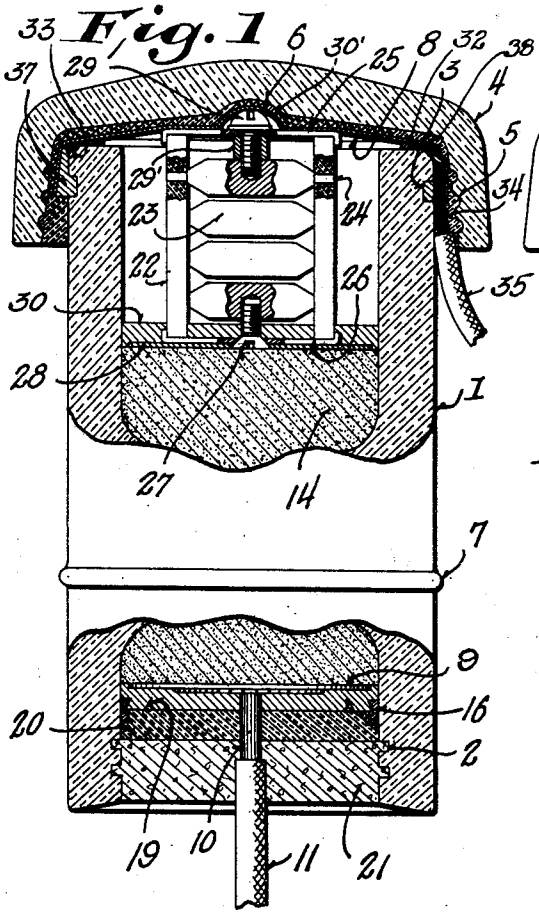


Fig. 2

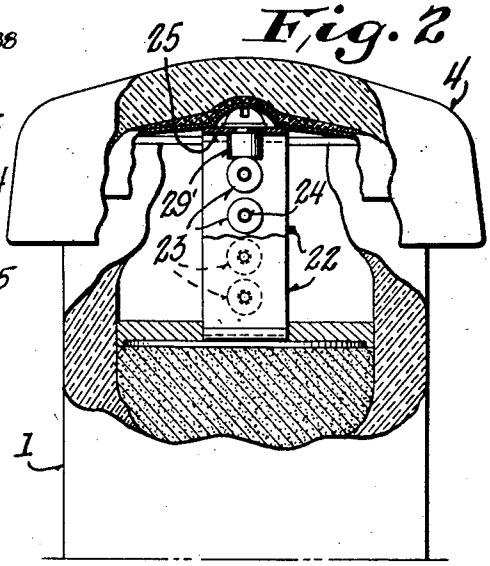


Fig. 3

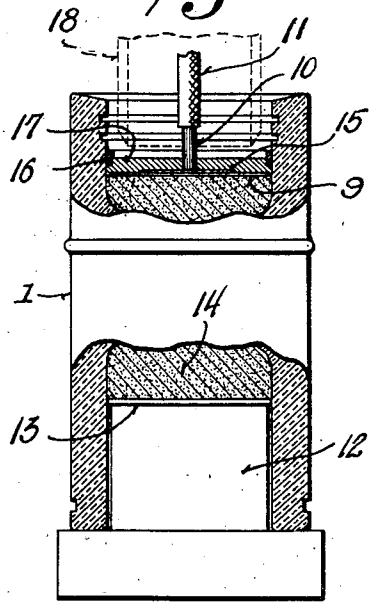
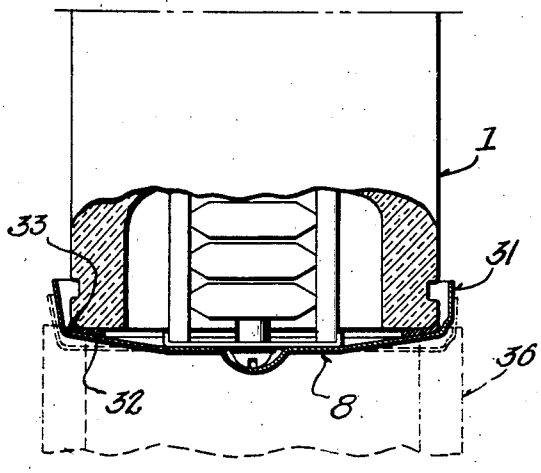


Fig. 4



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PROTECTIVE DEVICE

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Fig. 5

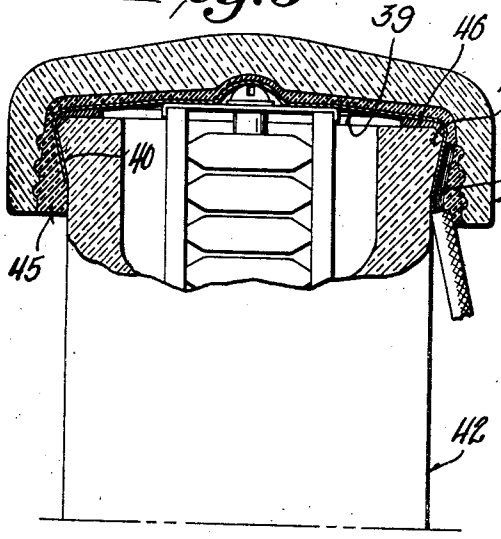


Fig. 6

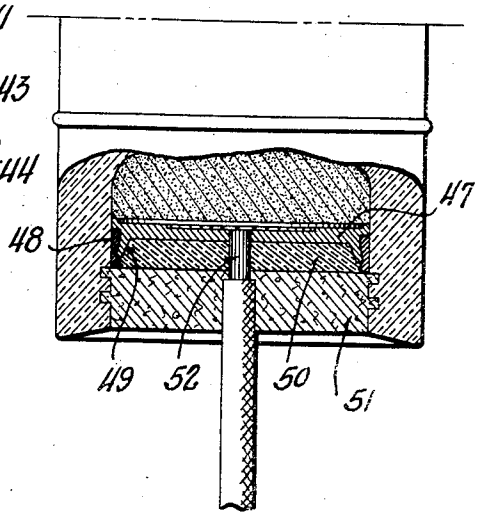


Fig. 8

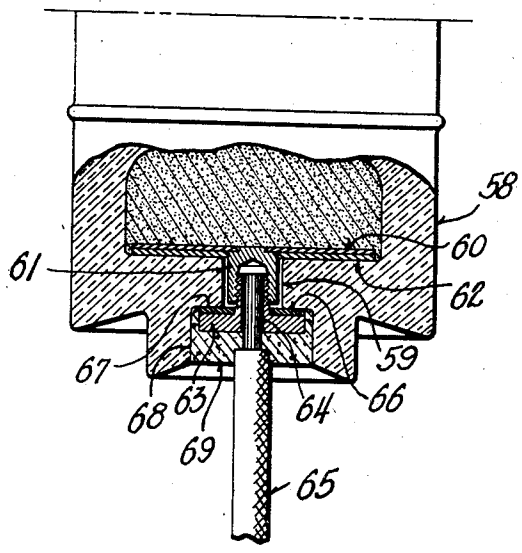
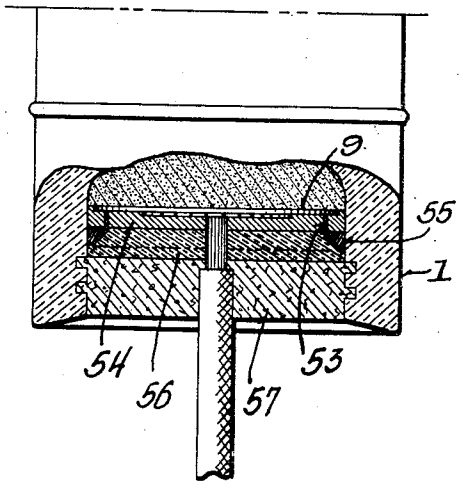


Fig. 7



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Patented Feb. 4, 1936 2,029,562

UNITED STATES PATENT OFFICE

2,029,562

PROTECTIVE DEVICE

Ralph H. Earle, Wauwatosa, Wis., assignor to Line Material Company, South Milwaukee, Wis., a corporation of Delaware

Application February 27, 1933, Serial No. 658,714

22 Claims. (Cl. 175—30)

This invention relates to protective devices, such as lightning arresters, for the protection of electrical distribution systems and conductors from disturbances or electrical stresses due to lightning, static, switch surge conditions, resonance, or other effects.

Objects of this invention are to provide a lightning arrester which has a low relief voltage, which has a high discharge rate, and which has a small follow-through current.

Further objects are to provide a protective device, such as a lightning arrester, in which a spark gap and a body of granular material are employed, in which the granular material may be in a loose form and is completely sealed against the entrance of moisture, gases, or other detrimental agents, and is protected against the effects from carbonization of any part of the device so that all internal portions of the arrester are free from the action of any conducting or carbonizing gases or materials, and in which the arrester has a very long life even when exposed to atmospheric conditions throughout its entire period of operation.

Further objects are to provide a lightning arrester in which a porcelain or other hollow body portion is employed, in which the upper and lower electrodes are sealed in place in an air-tight and waterproof manner, in which provision is made for a wide variation in the shape or size of the porcelain so that although the porcelain may be misshaped due to the process of manufacture, that nevertheless a water-tight and air-tight seal is secured under all conditions.

In greater detail, objects of this invention are to provide a lightning arrester in which a metallic alloy is employed which securely locks one of the electrodes, for instance the lower electrode, to the porcelain housing which binds a rubber gasket or other yielding gasket in place, which prevents the contact of the rubber or other gasket with the granular material, such as silicon carbide, commonly known as granulon, or other similar material, and which prevents the sparking which occurs in the crystal mass or granular mass from affecting the rubber or other gasket, and thereby prevents the formation of any carbonaceous material or any conducting or harmful gas within the arrester.

Further objects are to provide a lightning arrester in which a novel form of spark gap is employed, which may be separately calibrated from the arrester, and in which a novel form of metal cap is employed which, together with the metallic alloy, closes one end, for instance the upper end, of the arrester, which acts as a diaphragm and maintains the loose granular material under pressure, which centers the top or end of the spark gap and forms a firm electrical contact therewith, which has no hole therein and is, therefore, free from the possibility of leaking, and which is so made that it will not be deformed by internal pressure or an internally formed vacuum.

Further objects are to provide a novel manner in which the upper cap is sealed to the porcelain housing by the use of type metal or other alloy and to provide a novel means of not only sealing this cap but also sealing the lower electrode so that when the metallic seals are poured into place, the conducting wires or stranded cables are firmly bonded to the electrodes and the individual wires of the stranded cable are bonded together, thereby preventing any possible capillary action from taking place and preventing corrosion at these points.

Further objects are to provide a novel form of seal for a lightning arrester in which expansion and contraction due to thermal differences between the various materials is taken care of to avoid bursting of the housing due to internal pressure, and to permit one electrode to move longitudinally with the gap member to always insure firm contact with the granular material at both electrodes, although the material or other parts of the structure may expand and contract, in which the metallic alloy seal prevents the sifting of the particles out of position, and in which the metallic seals directly engage the electrodes and the porcelain and thereby prevent the formation of a corona.

Further objects are to provide a lightning arrester or protective device which readily lends itself to ordinary manufacturing steps, which is easy to produce, and which is reliable in operation.

Embodiments of the invention are shown in the accompanying drawings, in which:—

Figure 1 is a view, partly in section, showing one form of the invention.

Figure 2 is a view of the upper portion of Figure 1, such view being broken away and being at right angles to Figure 1.

Figure 3 is a view, partly in section showing the device partly completed.

Figure 4 is a detail showing a further step in the manufacture of the device.

Figure 5 is a view corresponding to Figure 1 showing a further form of the invention, such view showing the upper end of the device.

Figure 6 is a view of the lower end of a still further form that the device may take.

Figure 7 is a view corresponding to Figure 6 showing a further modified form of bottom seal.

Figure 8 is a view corresponding to Figure 6 showing a still further form of bottom seal.

Referring to Figures 1, 2, 3, and 4, it will be seen that the protective device or lightning arrester comprises a porcelain housing 1 which is tubular and has a straight bore throughout. It may be provided with one or more internal grooves 2 adjacent its lower end and with one or more external grooves 3 adjacent its upper end. In the form shown, two lower internal grooves are shown and one upper external groove, though, of course, the number may be varied as desired. The top 4 of the device is also of porcelain and is preferably provided with a plurality of internally arranged grooves 5 in its downwardly flaring flange. The cap 4 is preferably provided with a depression 6 on its underside for a purpose hereinafter to appear, and it is also preferable to form an annular rib 7 on the exterior of the body portion 1 to facilitate clamping the device in place.

The lightning arrester is provided with an upper cap electrode 8 formed of brass or springy copper, preferably the latter. This electrode is preferably tinned and acts not only as a closure for the upper portion of the device, but also acts as a centering contact member for the spark gap hereinafter described.

The lower electrode 9 consists of a tinned brass plate to which is secured the ground conductor 10, which is stranded wire cable provided with insulation 11, as shown in Figure 1.

At this point it is believed that the invention will be more readily appreciated if the steps in the process of making it are given.

In making the device it is preferable to invert the body portion, as shown in Figure 3, and to insert a wooden block 12 in the then bottom portion of the device—in reality the top of the body portion. A disk 13 in the form of a temporary gasket may be applied at the upper end of the block to temporarily hold the granular material in place. Granular crystalline valve material 14 is poured into the body portion until it is filled to approximately the position shown. This material may be silicon carbide, which is commonly known as granulon, or it may be other similar material. The tinned brass plate 9 is then positioned. The stranded conductor 10 has its ends outwardly flared or turned, as indicated at 15 and held in contact with the brass plate 9. The stranded conductor 10 has its end thoroughly tinned so as to fit all of the interstices between the several strands forming the conductor and to prevent the formation of any space whatsoever among the strands at this exposed portion to thereby reduce capillary action.

When the parts are in the position indicated, a rubber gasket 16, whose external diameter is slightly greater than the internal diameter of the body portion 1, is positioned as shown in Figure 3. Thereafter a relatively low fusing point metal alloy, such as type metal, is poured into the apparatus and is indicated by the reference character 17. This alloy extends about half way of the rubber gasket, as shown in Figures 1 and 3.

While the device is in this position, a hollow punch 18, having an outwardly bevelled edge, is forced down into engagement with the type metal 17 and expands the type metal adjacent its periphery so that it takes the form shown in Figure 1, thus forming the rubber gasket 16 into a double wedge, as shown clearly in Figure 1. The punch, in other words, forms an annular groove 19 in the type metal and thus expands what becomes its lower periphery, causing intimate engagement with the rubber gasket and causing compression of the rubber gasket into the double wedge-shape previously noted.

It is to be noted also that the type metal 17 bonds or solders the tinned end of the stranded cable conductor 10 to the tinned brass plate 9 so that an intimate bonding of these parts is secured, and therefore there are no spaces formed between any of the strands of the conductors and the tinned plate. In addition to this, the type metal flows over and around the edges of the plate 9, as shown in Figures 3 and 1, and adjusts itself to irregularities in the contour or size of the porcelain body portion, very accurately sealing itself in place and preventing the escape of any of the granular material.

While the apparatus is in its inverted position as shown in Figure 3, it is preferable to partially fill the exposed end with a fairly soft asphalt cement, indicated by the reference character 20 in Figure 1. This asphalt cement covers up the exposed portion of the rubber and also forms a somewhat yielding seal just back of the type metal. After this asphalt has hardened, a cement seal, indicated at 21, is poured into place. The cement runs into the annular internal grooves 2 formed in the body portion and thus positively locks the seal in place, preventing longitudinal shifting thereof and also preventing any outward motion of the asphalt seal even if this seal should become softened, as where the device was mounted in an extremely hot location.

The sealing material may be a sulphur compound, such as that known as basolite. It is a hard material having a high dielectric constant. It does not soften even under unusual conditions. It is obvious, however, that this invention in its broader aspects could employ either a seal wholly of asphalt or one wholly of the cement material, though the form shown is preferred.

It is to be noted particularly that the insulation 11 of the ground conductor is removed for a material distance away from the bottom electrode and that the bare portion of the conductor is sealed not only in the type metal but also in the usual seal and in a part of the cement seal. This construction prevents the siphoning of water into the apparatus and prevents any capillary action whatsoever, so that there is no chance for the entrance of moisture and also so that an entirely air-tight, gas-tight and water-tight seal is obtained.

At this point it is to be noted particularly that the seal automatically adapts itself to wide variations in the size or shape of the porcelain body portion. These body portions vary greatly due to irregularities resulting in the manufacture thereof and are sometimes of considerably different sizes, as well as out of round. However, this invention takes care of all of these variations and not only accommodates the seal to the shape or size of the body portion, but also secures a hermetically tight seal.

It is to be noted that the rubber gasket binds tightly against the body portion and it has been found that due to the heat of the type metal, that a slight vulcanizing action takes place, causing the rubber gasket to adhere even more firmly to the body portion.

Due to the double wedge-shape of the rubber gasket, as shown in Figure 1, it is apparent that

this gasket tends to wedge even if gas pressure should reach it, either from the inside or outside so that even under the most adverse conditions, a secure seal is obtained.

In considering this lower seal it is to be further noted that the asphalt has no definite melting point but gradually softens, whereas the cement has a definite melting point and does not gradually soften as in the case of asphalt.

Also it is to be noted that there is sparking between the crystals of the granular material **14** when a lightning discharge takes place. However, by means of the seal hereinabove described it is obvious that neither the rubber gasket nor the asphalt seal can come into contact with the granular material under any condition. Consequently, they will not produce conducting gases or carbon deposits within the apparatus and consequently there will be no deterioration due to this effect. Also leakage at the spark gap or other parts of the device is avoided as no smoke or fumes can get into the device, as there is no exposed combustible material or decomposable material adjacent or in contact with the granular material.

After the bottom seal has been formed, the device is inverted and the spark gap assembly is positioned. This spark gap assembly consists of a pair of uprights or side pieces **22** formed of ceramic material having high heat resisting characteristics and high insulating value. A plurality of electrodes, indicated by the reference character **23**, are carried by the side members **22** and are preferably provided with projecting trunnion-like portions **24** fitting within drilled holes in the members **22**.

These electrodes consist of solid turned metal electrodes. They may be of brass or other suitable metal. The upper and lower electrodes are each provided with a tapped hole for a purpose hereinafter to appear. This spark gap is provided with an upper end plate or member **25** and a lower end plate or member **26**. These members **25** and **26** may consist of metal, straplike pieces which extend across the ends of the ceramic insulators **22** and have inwardly turned flanges to hold such side pieces in place. Each is held in place by means of a screw. The lower screw **27** may have a tapered head and may pass through the end plate or member **26** only, or it may pass through the disklike upper electrode **28**, the latter construction being shown in Figure 1, though it is to be distinctly understood that either construction could be used.

The upper screw **29** is preferably a round headed screw as shown and passes through the upper end member or plate of the spark gap and preferably through a spacer **29'** and into the uppermost electrode. These screws therefore lock the spark gap assembly together and make a unitary structure.

The spark gap per se forms the subject matter of my companion application, Serial No. 662,443, filed March 24, 1933, for Lightning arresters, specifically directed to this structure. However, it is to be noted that the spark gap provides relatively sturdy, strong and heavy electrodes free from sharp points and presenting extensive cylindrical surfaces towards each other.

After the spark gap assembly is positioned as shown in Figure 1, type metal, as indicated at **30**, is poured into the upper end of the apparatus until it fills to a depth about as shown in Figure 1. This type metal securely bonds the bottom member **26** of the spark gap, which has been previously tinned to the tinned brass plate **28**.

Thus it is possible to use a spark gap which may be wholly distinct from the plate **28**, as previously described, and even when a spark gap is used where the attaching screw **27** passes through both the plate **28** and the member **26**, nevertheless a very firm soldered joint is also provided betwen the plate and the end portion of the spark gap.

It is to be noted particularly that in cooling, this type metal shrinks slightly and therefore slightly frees itself from the body portion **1** so that it may adjust itself slightly to compensate for expansion or contraction of the crystalline or granular material **14**. It fits so closely to the body portion, however, that there can be no sifting out of the granular material.

The upper portion of the apparatus is closed by means of a copper or brass closure cap **8** which has previously been referred to. This cap is provided with an upwardly bulged, centrally located portion **30'** which is slightly less in depth than the head of the screw **29** so that it bears firmly against the head of the screw and acts to center the spark gap assembly and also acts as a connector between the upper cap and the spark gap assembly.

It is preferable to form this cap with a tinned inner surface.

In positioning the cover reference is directed to Figure 4, from which it will be seen that the closure cap **8** initially had a substantially straight upper surface, as shown in dotted lines. It is provided with an inwardly turned flange **31** which surrounds and is spaced from the body portion **1**.

Further, from reference to Figures 1 and 2, it is to be noted that a rubber gasket **32** is positioned between the upper outer corner of the body portion and the cap **8**. This corner portion is provided with a bevel, as indicated at **33**, so as to form the rubber gasket **32** into a double wedge, as shown in Figure 1, and as will appear as the description proceeds. When the parts are assembled as described up to this point, the entire device is inverted and the cap **8** is forced into contact with the end of the body portion, as shown in full lines in Figures 1 and 4. During this operation it will be noted that the cap **8** contacts with the end of the spark gap assembly and presses down on it to a predetermined extent, depending on the initial spacing of the cap from the end of the body portion **1**. This part of the cap is firmly contacting with the shaping tool and no tendency to bulge upwardly is produced in the cap. The bared end **34** of the conductor is inserted under the flanges **31** on one side of the device, as shown in Figure 1, the insulation **35** having been removed for a material distance, as shown in Figure 1. Thereafter a forming tool, as indicated in dotted lines at **36** in Figure 4, forces the cap **8** into the full line position and subsequently type metal is poured into the flange so that it fills the flange, bonds thereto and tightly binds against the body portion **1**.

Also this type metal bonds or solders the tinned end **34** of the stranded conductor to the upper cap or electrode **8**. The type metal is indicated at **37** in Figure 1 and interlocks with the groove **3**, thus holding the cap **8** in tension and forcing the spark gap assembly downwardly, thereby maintaining the granular material under a substantially uniform compression.

Subsequently the porcelain cap **4** is positioned

and an insulation, as indicated at 38, either of asphalt or of cement material is poured into the flange of the cap, thus cementing the cap in place and also sealing around the bared end 34 of the conductor and around the unbared end thereof to prevent the entrance of water even at this point.

It is to be noted that the insulation 38 may flow completely across the cap or it may flow only into a portion thereof. At all events it fully fills the flanged part and the adjacent parts.

It is to be noted, however, that the strands of the conductor are all tightly bound together by their previous tinning and all spaces are filled. In addition, the type metal completely seals the bared end of the conductor within the flange and consequently there is no chance for corrosion of the parts due to the drawing of moisture inwardly by capillary action. A gas-tight and water-tight seal is thus secured.

It is to be noted particularly that the upper metal cap forms with the type metal a positive and secure gas-tight and water-tight seal. In addition, it provides a yielding, springlike member which will accommodate expansion or contraction of the granular material or of the different parts of the apparatus, so that no bursting of the porcelain housing can occur. In addition, it maintains a substantially constant pressure on the granular material.

Referring to Figure 5, it will be seen that the upper cap member may be secured in other ways from that shown. In one form of the invention this cap member 39, as shown in Figure 5, is provided with a downwardly extending flange 40 which is spun inwardly and interlocks with an outwardly flaring upper end 41 of the body portion 42. In this form of the invention, the end 43 of the conductor is bared and soldered to the outer surface of the flange 40. Thereafter the porcelain cap 44 is positioned and insulation 45 is poured into place. This cap also provides a downward pressure on the spark gap assembly and acts therefore in the same general capacity as the cap previously described. The same advantage of additional sealing is obtained by the double wedge rubber ring 46 as that previously described.

It is to be noted also that other types of bottom seals may be employed without departing from the spirit of the invention. In the form shown in Figure 6, the bottom seal 47 is formed of type metal and the lower rubber gasket 48 is employed. However, this metal seal is provided with a cast, downwardly extending flange 49 which is subsequently spun outwardly or forced outwardly so as to compress the rubber gasket 48, as shown in Figure 6. Subsequently the successive seals of asphalt 50 and cementing material 51 are employed, as previously described. The bonding or soldering of the bared end 52 of the lower or ground conductor is secured in the same manner as that previously described.

A further form of bottom seal is shown in Figure 7. In this form of the invention it is to be noted that a metal ringlike member 53 is positioned in contact with the bottom plate 9. Subsequently a layer of type metal 54 is poured until it forms a layer as shown in Figure 4, the pouring in each case being, of course, when the apparatus is inverted, as described in connection with Figure 3. Ordinarily this flange or ring-like member 53 is substantially cylindrical and a rubber gasket 55 is positioned between the protruding portion of the member 53 and the wall of the housing 1. Thereafter the protruding end of this member 53 is spun over so as to compress the rubber gasket and subsequently the successive asphalt and cement seals, indicated at 56 and 57, are poured into place.

In the form of the invention shown in Figure 8, the body portion 58 is differently shaped adjacent its lower portion as shown. It is provided with a bottom part which is closed except for a centrally located aperture 59. The bottom brass plate 60 carries an internally apertured and threaded fitting 61 which loosely seats within the aperture 59.

A lead gasket 62 is positioned between the plate 60 and the bottom wall of the body portion 58. A fitting in the form of a clamping nut 63 surrounds the bared end 64 of the conductor, the insulation 65 being removed to the point shown in Figure 8. This fitting is soldered tightly to this bared end 64 and all portions of the strands are bonded together, either by prior tinning or at this operation. The fitting 63 is provided with a threaded shank which is screwed into the fitting 61, a rubber gasket 66 being provided and being clamped tightly against a small annular shoulder 67 formed on the body portion. The fitting 63 is received within an aperture 68 formed in the extreme bottom portion of the body 58 and this aperture is subsequently filled with cement, as indicated at 69, this cement or insulating material engaging the bared end of the conductor 64 and also engaging the insulation of the conductor to thus prevent any passage of water or moisture whatsoever to the fitting 63.

In this form of the invention as well as in all the other forms previously described, it will be seen that there is no possible chance for the granular material contacting with the rubber gasket. In the last described form the lead gasket takes care of any irregularities in the porcelain and also forms a seal to prevent the granular material from reaching the rubber gasket.

Only a few of the many possible forms that the invention may take have been described, although the invention obviously is capable of taking many different forms. Also it is to be noted that various combinations of different types of upper and lower seals may be employed in the same lighting arrester or protective device.

It will be seen that a novel form of protective device has been provided which may be connected between a distribution line and the ground so as to quickly discharge when an excessive voltage builds up either through lightning or other causes. Also it will be seen that a very large body of granular material has been provided so that excessive heating of this part of the apparatus cannot occur. In addition, the spark gap construction cooperating with this granular material has a substantial mass of metal and consequently does not become heated and tend to prolong the arc. Instead, the arc is quickly quenched and also the follow-through current is very much restricted through the resistance offered by the granular material. The net result of this is that a lightning arrester or protective device has been provided which has a low relief voltage and high discharge rate and a small follow-through current.

Another feature inherent in lightning arresters constructed in accordance with this invention resides in the fact that no arc gap is formed immediately adjacent the granular material. Consequently there is no possibility of any undue heating due to the formation of an arc immediately

adjacent the granular material and therefore such lightning arresters would be free from the possibility of causing indefinite arcing due to excessive heating and vaporization of the granular material.

Also lightning arresters constructed in accordance with this invention will last a great length of time as there is substantially no deterioration of the parts. Further, a protective device or lightning arrester constructed in accordance with this invention will be hermetically sealed and also will be protected against the formation of any carbon deposits or conducting gases within the apparatus itself, due to the inability for carbonization of any of the sealing members to occur.

Further than this, it will be seen that the granular material is maintained in a yieldingly compressed state with a predetermined substantially constant pressure.

This protective device may be very readily made in a simple manner. The body portion is a substantially straight cylindrical member, it may be very easily formed, and all of the parts forming this lightning arrester are of simple, rugged and reliable construction.

Although this invention has been described in considerable detail, it is to be understood that such description is intended as illustrative rather than limiting, as the invention may be variously embodied and is to be interpreted as claimed.

I claim:

1. In a protective device, an insulating tubular housing, a metal plate located within said housing adjacent one end thereof, means for holding said metal plate in place, a second metal plate spaced from said first mentioned plate, a mass of granular material located between said plates, a spark gap connected to said second plate and located within said housing, and a metal seal connected to said second plate and exactly conforming to the interior of said housing.

2. In a protective device, an insulating tubular housing, a metal plate located within said housing adjacent one end thereof, means for holding said metal plate in place, a second metal plate spaced from said first mentioned plate, a mass of granular material located between said plates, a spark gap connected to said second plate and located within said housing, and a metal seal connected to said second plate and conforming to the interior of said housing, said metal seal being molded in place within said housing.

3. In a protective device, an insulating tubular housing, a metal plate located within said housing adjacent one end thereof, means for holding said metal plate in place, a second metal plate spaced from said first mentioned plate, a mass of granular material located between said plates, a spark gap connected to said second plate and located within said housing, and a metal seal connected to said second plate and conforming to the interior of said housing, said metal seal being composed of low melting point metal molded in place within said housing.

4. In a protective device, an insulating tubular housing, a metal plate located within said housing adjacent one end thereof, means for holding said metal plate in place, a second metal plate spaced from said first mentioned plate, a mass of granular material located between said plates, a spark gap connected to said second plate and located within said housing, and a metal seal connected to said second plate and conforming to the interior of said housing, said metal seal being composed of type metal molded in place within said housing.

5. A protective device comprising an insulating tubular housing, a metal plate adjacent one end of said housing, means for holding said metal plate in place, a second plate located at an intermediate point within said housing, a mass of granular material located between said plates, a spark gap assembly located within said housing and contacting with said second plate, and a soft metal seal bonding one end of said spark gap assembly to said plate and conforming to the interior of said housing.

6. A protective device comprising an insulating tubular housing, a metal plate adjacent one end of said housing, means for holding said metal plate in place, a second plate located at an intermediate point within said housing, a mass of granular material located between said plates, a spark gap assembly located within said housing and contacting with said second plate, a soft metal seal bonding one end of said spark gap assembly to said plate and conforming to the interior of said housing, said metal seal being molded in place within said housing and shrinking away from said housing, whereby said seal is slidable with respect to said housing, and yielding means for compressing said mass of material and acting through said spark gap assembly.

7. In a protective device having an insulating tubular housing, a spark gap, a mass of granular material contained within said housing and electrically connected to said spark gap, a metal plate adjacent one end of said housing contacting the said granular material, a soft metal seal molded in place within said housing and bonded to said metal plate and conforming accurately to the interior of said housing, and means for holding the granular material within said housing.

8. In a protective device, an insulating tubular housing, a spark gap and a mass of granular material electrically connected thereto and enclosed within said housing, a metal plate contacting with the mass of granular material, a conductor extending from said metal plate outwardly of said housing, and a soft metal seal bonding said conductor to said metal plate and conforming accurately to the interior contour of said housing.

9. In a protective device, an insulating tubular housing, a mass of granular material contained within said housing, a spark gap connected to said mass of granular material, a metal plate adjacent one end of said housing, a stranded conductor leading from said metal plate outwardly of said housing and having the strands thereof spread over said metal plate, a soft metal seal molded in place within said housing and bonded to the stranded conductor and to said plate and accurately conforming to the interior contour of said housing, and a yielding gasket held in place by said soft metal seal and compressed by said soft metal seal into intimate contact with the interior of said housing, said gasket being spaced by said soft metal seal from said granular material.

10. In a protective device, an insulating tubular housing, a mass of granular material contained within said housing, a spark gap connected to said mass of granular material, a metal plate adjacent one end of said housing, a stranded conductor leading from said metal plate outwardly of said housing and having the strands thereof spread over said metal plate, a soft metal

seal molded in place within said housing and bonded to the stranded conductor and to said plate and accurately conforming to the interior contour of said housing, a yielding gasket held in place by said soft metal seal and compressed by said soft metal seal into intimate contact with the interior of said housing, said gasket being spaced by said soft metal seal from said granular material, and an insulating seal molded in place within said housing and engaging the interior of said housing and said conductor.

11. In a protective device, an insulating tubular housing, a mass of granular material contained within said housing, a spark gap connected to said mass of granular material, a metal plate adjacent one end of said housing, a stranded conductor leading from said metal plate outwardly of said housing and having the strands thereof spread over said metal plate, a soft metal seal molded in place within said housing and bonded to the stranded conductor and to said plate and accurately conforming to the interior contour of said housing, a yielding gasket held in place by said soft metal seal and compressed by said soft metal seal into intimate contact with the interior of said housing, said gasket being spaced by said soft metal seal from said granular material, and an insulating seal molded in place within said housing and engaging the interior of said housing and said conductor, said insulating seal having portions interlocking with the interior of said housing.

12. In a protective device, an insulating tubular housing, a spark gap located within said housing and having a metal plate at its inner end, a mass of silicon carbide crystals contacting with said metal plate, a second metal plate adjacent one end of said housing and engaging said mass of crystals, means for holding said second metal plate in place within said housing, a conductor leading outwardly of said housing and contacting with said metal plate, a yielding annular gasket spaced outwardly from said last mentioned metal plate, a soft metal seal molded in place in contact with said gasket and bonding said conductor to said metal plate and forming a spacing material between said gasket and said crystals.

13. In a protective device, an insulating tubular housing, a spark gap located within said housing and having a metal plate at its inner end, a mass of silicon carbide crystals contacting with said metal plate, a second metal plate adjacent one end of said housing and engaging said mass of crystals, means for holding said second metal plate in place within said housing, a conductor leading outwardly of said housing and contacting with said metal plate, a yielding annular gasket spaced outwardly from said last mentioned metal plate, a soft metal seal molded in place in contact with said gasket and bonding said conductor to said metal plate and forming a spacing material between said gasket and said crystals, said soft metal seal having a peripheral portion thereof forced outwardly and said gasket being in the form of a double wedge.

14. In a protective device, an insulating tubular housing, a spark gap located within said housing and having a metal plate at its inner end, a mass of silicon carbide crystals contacting with said metal plate, a second metal plate adjacent one end of said housing and engaging said mass of crystals, means for holding said second metal plate in place within said housing a conductor leading outwardly of said housing and contacting with said metal plate, a yielding annular gasket spaced outwardly from said last mentioned metal plate, a soft metal seal molded in place in contact with said gasket and bonding said conductor to said metal plate and forming a spacing material between said gasket and said crystals, said soft metal seal having a peripheral portion thereof forced outwardly and said gasket being in the form of a double wedge, and a second seal formed of insulating material and located outwardly of said soft metal seal, said second seal interlocking with said housing.

15. In a protective device, an insulating tubular housing, a spark gap and a mass of granular material contained within said housing, a cup-shaped metal cap closing the upper end of said housing, a soft metal seal molded between said cap and said housing and bonded to said cap and interlocking with said housing, and means for holding said granular material within said housing.

16. In a protective device, an insulating tubular housing, a spark gap forming a rigid structure, and a mass of silicon carbide crystals electrically connected to said spark gap and enclosed within said housing, a metal plate contacting with one end of said spark gap and sprung downwardly to transmit pressure through said spark gap to said mass of crystals, said metal plate forming a cap for said housing and having a downwardly turned annular flange surrounding the end of said housing, a soft metal seal molded in place between said housing and the flange of said metal plate and bonded to the flange of said metal plate, said soft metal seal interlocking with said housing, an insulating cap located above said metal plate, an insulating seal molded in place between said insulating cap and said housing, and means for holding said crystals within said housing.

17. In a protective device, an insulating tubular housing, a lower metal plate located within said housing adjacent the lower portion thereof, a mass of silicon carbide crystals positioned above said metal plate, an upper metal plate contacting with the upper portion of said mass of crystals, a rigid spark gap extending upwardly from said second metal plate, a spring metal cap having a depression formed therein for centering said spark gap and being swung downwardly to exert pressure upon said mass of crystals, through said spark gap, said metal plate having an annular flange overhanging the upper end of said housing, a conductor located within the outline of said flange, a soft metal seal molded in place and bonded to said conductor and to said flange, said soft metal seal interlocking with said housing, an annular yielding gasket between the upper end of said housing and said spring metal cap, said gasket being double wedge-shaped in cross-section, a conductor extending downwardly from said first mentioned metal plate, and a second soft metal seal molded in place within said housing and bonding said conductor to said first mentioned metal plate and accurately conforming to the interior of said housing.

18. In a protective device, an insulating tubular housing, a lower metal plate located within said housing adjacent the lower portion thereof, a mass of silicon carbide crystals positioned above said metal plate, an upper metal plate contacting with the upper portion of said mass of crystals, a rigid spark gap extending upwardly from said second metal plate, a spring metal cap having a depression formed therein for centering said

spark gap and being sprung downwardly to exert pressure upon said mass of crystals, through said spark gap, said metal plate having an annular flange overhanging the upper end of said housing, a conductor located within the outline of said flange, a soft metal seal molded in place and bonded to said conductor and to said flange, said soft metal seal interlocking with said housing, an annular yielding gasket between the upper end of said housing and said spring metal cap, said gasket being double wedge-shaped in cross-section, a conductor extending downwardly from said first mentioned metal plate, a second soft metal seal molded in place within said housing and bonding said conductor to said first mentioned metal plate and accurately conforming to the interior of said housing, and means interlocking with said housing and preventing longitudinal shifting of said second metal seal.

19. In a protective device, an insulating tubular housing having a bevelled upper edge, a mass of silicon carbide crystals located within said housing, a spark gap located within said housing and electrically connected to said crystals, means contacting with the lower portion of the mass of crystals and held against motion with reference to said housing, a metal cup-shaped cap closing the upper end of said housing and sprung downwardly and locked to said housing, said cap exerting downward pressure on said spark gap and compressing the said crystals, an annular yielding gasket positioned between said metal cap and the bevelled portion of said housing and forming in cross-section a double wedge, and means for holding said crystals within said housing.

20. In a protective device, an insulating tubular body portion having a bevelled upper edge, a bottom plate, a soft metal seal bonded to said bottom plate and accurately conforming to the interior contour of said housing, means for holding said soft metal seal within said housing, a mass of crystals positioned above said metal plate, a yielding annular gasket spaced from said crystals, and wedged between said metal seal and the interior of said housing, an upper metal plate contacting with the upper portion of the mass of crystals, a spark gap electrically connected to said upper plate and projecting upwardly therefrom, a cup-shaped metal cap sprung downwardly and exerting pressure on said crystals through said spark gap and contacting with the upper portion of said spark gap, a soft metal seal bonded to said cap and interlocking with said body portion, and an annular yielding gasket located adjacent the bevelled upper end of said housing and positioned between said housing and said cap, said gasket having a double wedge shape in cross-section.

21. In a protective device, the combination of a spark gap assembly formed as a unitary, rigid unit, a granular mass of material electrically connected to said spark gap, a metal plate between said spark gap assembly and said granular material and permanently contacting with both said spark gap assembly and said granular material, said metal plate being permanently attached to said spark gap assembly and forming a unitary portion with said spark gap assembly, and an insulating housing surrounding said spark gap assembly and said mass of material, said spark gap assembly having its individual elements inherently retained in assembled condition independent of its assembly within said housing.

22. In a protective device, an insulating tubular housing, a metal plate located adjacent one end of said housing, a second metal plate spaced from said first plate, a mass of granular material located between said plates, a spark gap assembly formed as a self held rigid unit located within said housing, said second metal plate permanently contacting with both said spark gap assembly and said granular material, said second metal plate being permanently attached to said spark gap assembly and forming a unitary portion with said spark gap assembly, means closing the end of said housing adjacent said spark gap assembly, and means closing the end of the tubular housing remote from the spark gap assembly.

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