

July 19, 1938.

L. S. BRACH

2,124,364

OVER-VOLTAGE PROTECTIVE DEVICE

Filed Jan. 7, 1935

3 Sheets-Sheet 1

Fig. 1

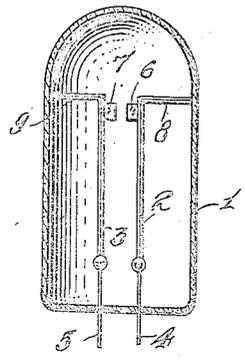


Fig. 2

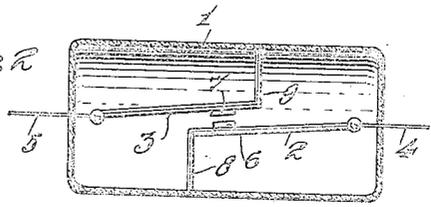


Fig. 3

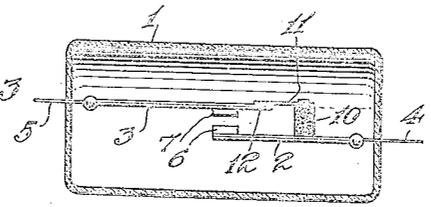


Fig. 4

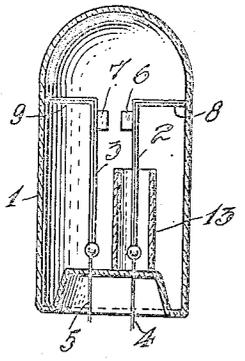


Fig. 7

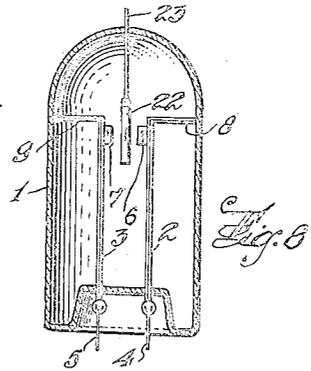
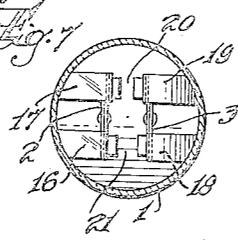


Fig. 6

Fig. 5

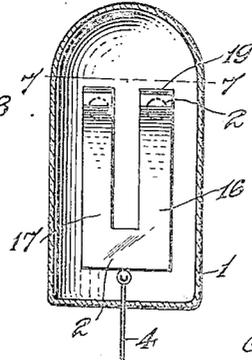
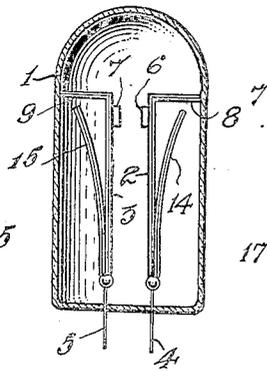
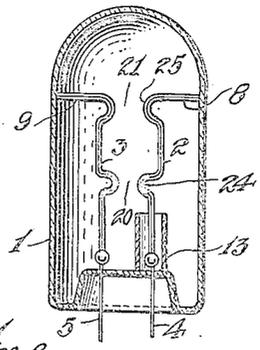


Fig. 9



INVENTOR
Leon S. Brach
BY
A. D. D. Libby
ATTORNEY

July 19, 1938.

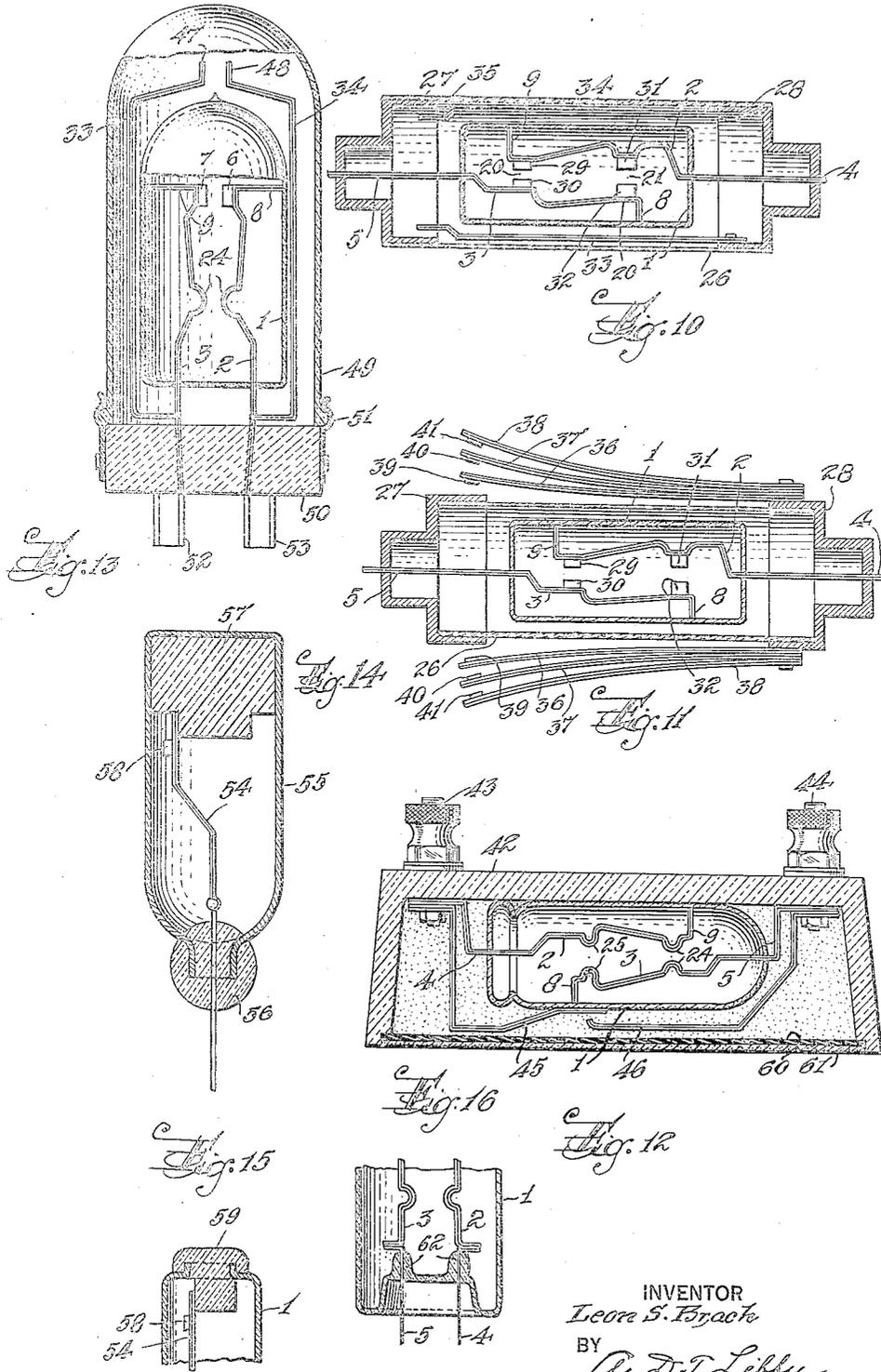
L. S. BRACH

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3 Sheets-Sheet 2



INVENTOR
Leon S. Brach
BY
A. D. T. Leiby
ATTORNEY

July 19, 1938.

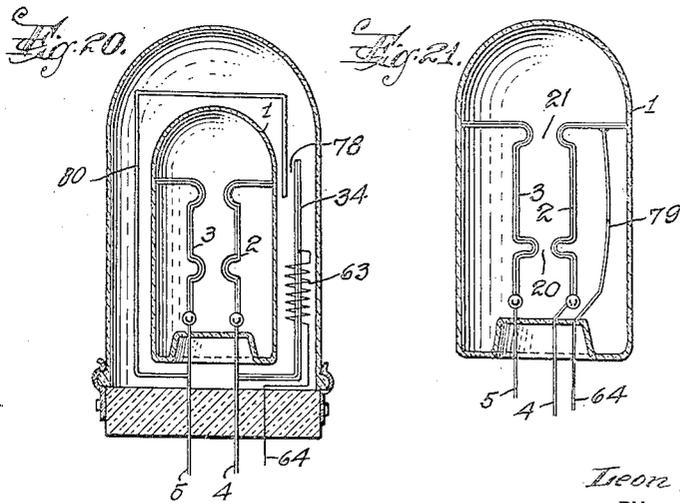
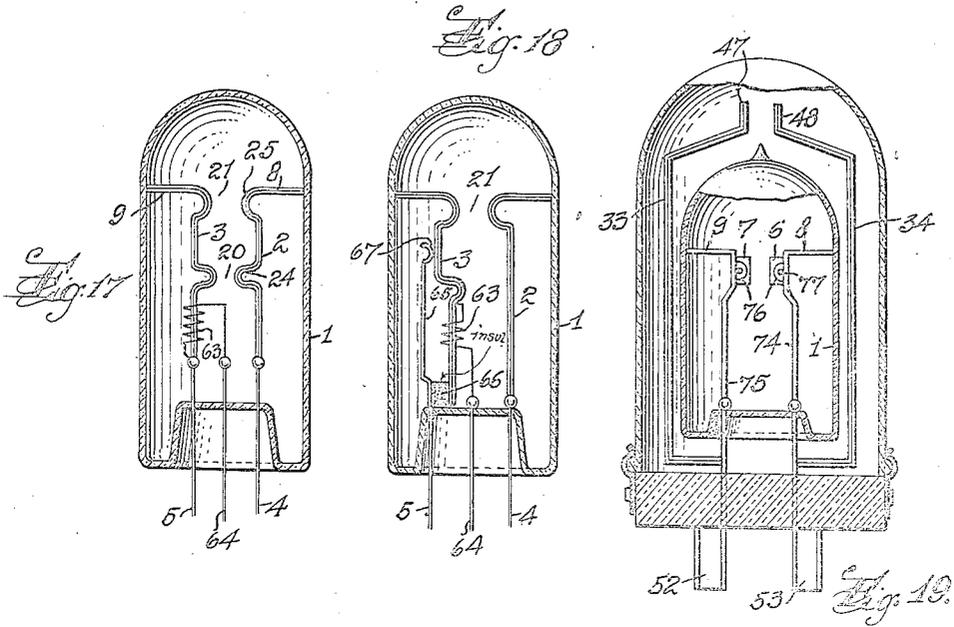
L. S. BRACH

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OVER-VOLTAGE PROTECTIVE DEVICE

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3 Sheets-Sheet 3



INVENTOR
Leon S. Brach
BY
A. D. T. Libby
ATTORNEY

UNITED STATES PATENT OFFICE

2,124,364

OVER-VOLTAGE PROTECTIVE DEVICE

Leon S. Brach, East Orange, N. J.

Application January 7, 1935, Serial No. 708

12 Claims. (Cl. 175—215)

This invention relates to improvements in arresters especially adapted for low voltage service.

Generally speaking, lightning arresters are primarily intended as protecting devices against a lightning discharge or an impulse resulting from such discharge. However, the term "lightning arrester" is also understood to include a protective device used to protect against an abnormal over-voltage current coming from another circuit. Such over-voltage may result from a surge induced from paralleling high-tension lines with a closely adjacent low voltage circuit, or a cross between the high-tension line and the low voltage line, thereby subjecting the arrester to a high voltage and heavy current.

Having heretofore designed lightning arresters using enclosed gaps, the enclosure being filled with some rare gas such as neon, and having observed the action of such arresters, and further having studied and observed the action of thermostatic bi-metallic strips in various arrangements, I have conceived the idea of combining a rare-gas-filled tube with thermostatic or bi-metallic strips to form gaps within such tubes, as well as exterior thereof, into an improved form of arrester.

In the manufacture of arresters of the vacuum or rare-gas type, using bi-metallic electrodes, whether the electrodes are supported by the lead-in wires or on a special electrode support, it is difficult, because of the large amount of heat generated between the electrodes on the passage of current therebetween, to secure a fixed dimension of the gap between two or more electrodes, and even though the gap may be originally established at a fixed distance, when current passes between the electrodes or a discharge takes place, the bi-metallic electrodes press against each other, which pressure tends to distort the electrodes; and on cooling, they will assume a different distance apart than they originally had. As far as I am aware, no means has so far been devised which will maintain a substantially uniform normal distance between the initial arcing gap of such electrodes with a sealed chamber.

I have found, after many measurements and observations of the operation of protective devices or arresters of the rare-gas type, that it is highly important for substantially uniform operation of the protective device to hold the normal distance between the initial arcing portions of the electrodes to a given predetermined value, and it is therefore one of the objects of my present invention to provide ways and means for preventing the contact-engaging parts of the

electrodes, or those portions of the electrodes between which the high voltage current passes, from separating beyond a predetermined distance after the discharge is passed and the source of over-voltage current removed, whereby the arrester electrodes may return to their normal position.

Another object of my invention is to provide an arrangement of electrodes so that the arc will be quenched in the shortest possible time.

Another object of my invention is to provide a protective device of the class to be described in which means are provided for insuring that the over-voltage current will jump between the electrodes within certain limits or areas.

Another object of my invention is to provide means for relieving, after a certain interval, the electrodes within the sealed chamber from the full discharge current that passes between the electrodes within the said chamber, or in other words, to provide means for preventing the tube or sealed-in chamber from being injured or destroyed from the over-voltage current if this continues to pass through the arrester for any great length of time.

Another object of my invention is to combine within a rare-gas tube, or immediately associated with it externally, features that will be responsive to abnormal current, so that this abnormal current will be either grounded or open-circuited, thereby having the arrester unit combine both protection for over-voltage and/or current.

A still further object of my invention is to provide physical protection from mechanical injury or from the elements to the auxiliary gap portions of an arrester and at the same time have these parts readily visible for inspection.

These and other objects will be clear to one skilled in this particular art after a reading of the specification taken in connection with the annexed drawings, which are more or less diagrammatic in form to better illustrate the application of the principles involved. In the drawings:

Figure 1 is a part-sectional and part-elevation view through one form of my over-voltage protective device, showing one pair of electrodes mounted within a sealed tube or chamber, the lead-in wires to the electrodes being at one end of the tubes.

Figure 2 is a view similar to Figure 1 but showing the lead-in wires coming out at opposite ends of the tubes.

Figure 3 is a modified form of the device shown in Figure 2.

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Figure 4 is a view similar to Figure 1, but showing an additional means for preventing the over-voltage current from jumping between the lead-in ends of the electrodes.

5 Figure 5 is a view similar to Figure 1, but showing additional or supplemental members for assisting in carrying the over-voltage current.

Figure 6 is a view similar to Figure 5, but showing a modified form of electrode.

10 Figure 7 is a view on the line 7-7 of Figure 6 with the parts turned ninety degrees.

Figure 8 is a modified form of the device shown in Figure 1.

15 Figure 9 is a modified form of the device shown in Figure 4.

Figure 10 shows a further modified form of my arrester in which parts exterior to the sealed chamber are used to protect the tube or chamber from being injured or destroyed on continued passage of the over-voltage current.

20 Figure 11 is a modification of the form shown in Figure 10.

Figure 12 shows a still further modified form of the structure shown in Figure 10.

25 Figure 13 is a still further modification of the form shown in Figure 10.

Figure 14 shows a still further modification of one form of my protective device.

30 Figure 15 shows a modification of the device shown in Figure 14.

Figure 16 is a partial view of the bottom portion of my new form of arrester, showing the manner of connecting the lead-in wires to the electrodes.

35 Figure 17 is a view of an arrester having electrodes similar to those shown in Figure 9, but in which an additional element is introduced to take care of "sneak" current.

40 Figure 18 is a modified form of the arrester shown in Figure 17.

Figure 19 is a slightly modified form of the arrester shown in Figure 13.

45 Figure 20 shows a modified form of a combination of the arrester shown in Figures 17 and 19.

Figure 21 shows a further modified form of the arrester.

50 In the various views, wherein like numbers refer to corresponding parts, 1 is a sealed tube or chamber, preferably of glass, having electrodes 2 and 3 positioned therein in spaced relation and having lead-in wires 4 and 5 electrically connected thereto. The electrodes 2 and 3 are made up of bi-metallic strips, each electrode thereby forming an automatic thermostat capable of responding to the application of heat. The electrodes 2 and 3 are provided with contacts or portions 6 and 7 which are adapted to be brought into engagement on passage of over-voltage current therebetween. These contacts may be of carbon to avoid fusing of the metal on passage of the current between the electrodes. When carbon contacts are used, I prefer to fasten these contacts to the metal of the electrodes 2 and 3 by spraying one side of the carbon contacts with a heavy layer of copper and then welding the copper to the electrode. Some other satisfactory way of applying the copper to the carbon may be used.

70 In other words, when the over-voltage current comes into the arrester on one of the lead-in wires and jumps from one of the contacts—say from 6 to 7—an arc is started which generates a relatively large amount of heat in a very short space of time, and this heat acts on the bi-

metallic thermostat strips 2 and 3, causing them to bend so as to bring the contacts 6 and 7 into engagement, thereby cutting out the arc. The exterior apparatus associated with the arrester to indicate the presence of such over-voltage current on the device is not shown as this forms no part of my invention, but it will be understood that this additional apparatus gives an indication of the presence of such over-voltage current so the attendant in charge may look into and remove the troublesome current.

After the electrodes 2 and 3 have cooled sufficiently, the electrodes separate, and to insure that this separation will come back to its normal initial value, I have provided means to bring about this desirable condition. I accomplish this by bending over the end 8 of the electrode 2 and the end 9 of the electrode 3, so that they engage the inner wall of the tube or chamber 1, which chamber is preferably evacuated and filled with an inert gas such as neon.

25 In Figure 2, the electrodes 2 and 3 are mounted within the chamber so that the lead-in wires come into the tube from opposite ends, otherwise the action is the same as of the device shown in Figure 1.

30 In Figure 3, the electrode 2 carries a member 10 which may be an insulator, and this in turn carries an insulator 11, preferably of mica, which overhangs at 12 the end of the electrode 3, thus acting to normally position the contacts 6 and 7 at a given predetermined distance apart.

35 In Figure 4, the electrode 2 is provided with an insulating sleeve 13, preferably of glass, so as to prevent the over-voltage current from passing between the electrodes 2 and 3 at any point near the lead-in wires 4 and 5. This construction is such as to force the over-voltage current to always jump between the contacts 6 and 7. This additional protective means may be used on all of the forms of arresters shown herein.

40 In Figure 5, the electrodes 2 and 3 have associated therewith auxiliary bi-metallic members 14 and 15 which are fastened to the electrodes 2 and 3 adjacent the point where the lead-in wires 4 and 5 come into the chamber.

45 When the over-voltage current passes between the contacts 6 and 7 and continues for a considerable interval of time, the heat generated causes the auxiliary bi-metallic elements 14 and 15 to operate so that their free ends come into engagement with the electrodes 2 and 3 at points adjacent the contacts 6 and 7, thereby reinforcing the current-carrying capacity of the electrodes 2 and 3, so that the danger of permanently injuring the electrodes 2 and 3 by the heavy over-voltage current is thereby lessened.

50 In Figure 6, the electrode 2 is divided into two arms 16 and 17, while the electrode 3 is divided into two arms 18 and 19. Each of the arms 16 to 19 inclusive carries contacts or contact-engaging portions, and in some cases I prefer to make the gap 20 between the arms 17 and 19 less than the gap 21 between the arms 16 and 18, so that the over-voltage current will jump between the shorter gap, and then if the current continues at an abnormal interval, the gap 21 will close to divide the current between the respective sets of arms.

70 In Figure 8, a metal plate 22 is shown as being fastened within the chamber between the contacts 6 and 7 and connected to a lead-in wire 23. Thus the over-voltage current may function between the electrode 2 and the ground plate 22 independent of the electrode 3, or the electrode

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3 may function with the ground plate 22 independent of the electrode 2.

In Figure 9, the electrodes 2 and 3 have formations 24 and 25 providing predetermined portions thereof for the passage of the over-voltage current therebetween. As in Figure 7, the gap 20 is preferably made smaller than the gap 21, so the initial discharge of the over-voltage current takes place between the gap 20, and if this continues for a length of time after the portions come into engagement, then the gap 21 will be closed, bringing into engagement the contact portions 25. This construction, causing the current to jump at a predetermined point on the bi-metallic strip, will cause it to flex more quickly.

In Figure 10, the tube or container 1 is positioned within a shell 26 of insulating material having metallic terminals or thimbles 27 and 28 which may be used for mounting the arrester between suitable spring clips. The lead-in wire 4 is connected to the thimble 28 and the lead-in wire 5 is connected to the thimble 27. In this form of protective device, the contact surface portions 24 of Figure 9 are replaced by contacts 29 and 30 to form the gap 20, while the surfaces 25 of Figure 9 are replaced by contacts 31 and 32 to form the gap 21. Exterior of the tube or container 1, are a pair of bi-metallic strips 33 and 34, one end of each being mounted to the thimble 28, while their free ends 35 are adapted to engage the interior surface of the thimble 27 when the bi-metallic elements 33 and 34 operate under the influence of the heat delivered from the tube 1 by reason of a prolonged passage of over-voltage current therethrough. As soon as the thermostat elements 33 and 34 contact with the thimble 27, the greater part of the current is shunted away from the tube portion of the arrester, it being understood that the strips 33 and 34 are considerably larger in current-carrying capacity than the electrodes 2 and 3.

In Figure 11, the tube construction is in general the same as in Figure 10, but the exterior automatic safety means is different. This automatic means consists of a plurality of bi-metallic strips 36, 37 and 38 which may be arranged in one or more groups around the periphery of the entire structure, two such groups of elements being shown in Figure 11. If the over-voltage current continues for an abnormal period of time, the bi-metallic element 36 is operated to cause its contact 39 to engage the metallic thimble 27. If the current and heating effect still continues, the strip 37 will cause its contact 40 to come into engagement with the end of the strip 36, and likewise, the contact 41 of the strip 38 will be brought into engagement with the strip 37, thereby successfully adding shunting elements around the tube portion of the arrester.

In Figure 12, the thermostat electrodes are shaped similar to those shown in Figure 9, but arranged in a manner similar to that in Figure 11, the entire tube structure being mounted, however, within a special casing 42 of glass which carries terminals 43 and 44 for making connection to the arrester. The housing 42 being made of glass, an observer can readily see the functioning of the parts within the tube 1. As a safety device around the tube 1, I provide bi-metallic strips 45 and 46 which act to shunt the tube arrester 1 in a manner somewhat similar to that described in Figure 10.

In Figure 13, the tube 1 has electrodes which are a combination of those shown in Figures 9

and 10. It also has protective thermostat elements the same as 33 and 34 of Figure 10, but in this case, the ends 47 and 48 are adapted to be brought into engagement by abnormal generation of heat by the tube 1, thereby shunting the current around the tube portion of the arrester. In this form of construction, the shell 49, made of any suitable material, preferably glass, may be fastened to a base 50 of insulating material as by means of snap springs 51. The base 50 carries terminals 52 and 53 for mounting the arrester in a suitable socket.

While the auxiliary electrodes 47 and 48 are enclosed within the shell or casing 49, it may be noted that the auxiliary electrodes 45 and 46 in Figure 12 are also fully enclosed within the casing 42 by means of suitable insulating strips 60 which may be held in place by any satisfactory means as cement 61.

In Figure 14, a single bi-metallic electrode 54 is sealed within a metallic chamber 55 which is supported by a glass sealing means 56. Within one end of the container 55 is positioned an insulator 57 preferably of porcelain which acts as a stop and positioning means for the free end of the electrode 54. The electrode 54 carries a contact 58 adapted to engage the metallic shell 55 on action of the bi-metallic thermostat 54 due to the passage of current from the contact 58 to the shell 55.

In Figure 15, the end of the metallic shell 55 may be sealed into a glass insulator 59 which also has a part acting as stop and positioning means for the free end of the electrode 54. The insulator 59 being made of glass, this acts as a window whereby the action of the thermostat element within the container 55 may be observed.

In Figure 16, the electrode ends 2 and 3 are formed away from each other and are connected to the lead-in wires 4 and 5 in a manner somewhat as shown. If desired, the electrodes 2 and 3 may rest on the insulating bosses 62 where the lead-in wires are brought through into the tube 1. This construction acts to prevent abnormal voltage from jumping from one electrode to the other at the points where the lead-in wires come into the tube. In other words, the construction is a preventive means which may be used in place of the insulating member 13 shown in Figure 9. It may be noted at this point that the ends of the electrodes 2 and 3, where they are joined to the lead-in wires, including the ends of the lead-in wires, may be covered with an insulating paint or varnish to prevent over-voltage from jumping across the electrodes at these points.

In Figure 17, one of the electrodes, for example 3, may be provided with a heating device in the form of a resistance coil 63, one end of which is connected to the electrode 3 at some point adjacent the place where the lead-in wire is connected to said electrode, while the other end of the coil 63 is carried out to a terminal 64. While the heater is shown as a coil 63, this may take some other form. In this arrangement, the lead-in wire 64 may be considered as the incoming line circuit, while the lead-in wire 5 may be considered as going to the instrument with which the arrester is associated. The other electrode connected to the lead-in wire 4 is connected to ground. Thus any current coming in over the lead-in wire 64 will pass through the heating unit 63 to the instrument, and if any current comes in on this circuit other than that normally intended, and which is referred to in this specification as a "sneak" current, it will in time cause

the heating unit 63 to flex the electrode 3, closing at least either one or both of the gaps 20 and 21, thereby grounding the circuit and taking the "sneak" current away from the instrument being protected by the arrester.

In Figure 18, a somewhat similar arrangement is provided except that the electrode 3 has two branches, one of which, 65, is a plain metallic contact member engaging the bi-metallic electrode 3 intermediate its ends, the fixed end of which is fastened to an insulator 66. However, in this case, that is, in Figure 18, the incoming circuit wire is connected to a lead wire 64, while the lead wire 5 is connected to the instrument, so that in the operation of the device "sneak" current coming in from the line at 64, through the heating unit 63, through the contact 67 and terminal 65, and the lead wire 5, sufficient heat is generated to flex the electrode 3 to close the gap circuit 21 and also open the contact 67. This will ground the electrode 3 to the electrode 2 and the flow of the "sneak" current through the unit 63 will hold this ground circuit closed and the instrument circuit open.

In both Figures 17 and 18, an over-voltage will jump the gaps and cause the bi-metallic elements to function as has been previously described. Thus the forms of arrester shown in Figures 17 and 18 act as a combination of voltage and current arresters.

In Figure 19, the arrester shown is the same as in Figure 13, except the electrodes 74 and 75 are plain metallic electrodes having, however, stops 8 and 9 and carbon contacts 6 and 7 which are shown as being held to their respective electrodes by ears 76 formed from their respective electrodes and having indentations 77 adapted to engage depressions in the carbon contacts 6 and 7.

In Figure 20, the bi-metallic electrodes 2 and 3 are similar to those shown in Figure 17, but the auxiliary electrode 80 may be carried over to the position shown, and arranged to engage the auxiliary electrode 34 which carries the "sneak" current coil 63. In this arrangement, the incoming line wire is connected to the lead-in wire 64, while the lead wire 5 is connected to ground. On passage of "sneak" current through to the instrument through the lead wire 4, a contact 78 will be closed between the bi-metallic electrode 34 and the auxiliary electrode 80, thereby grounding the circuit. In this arrangement, it is seen that the "sneak" current does not enter the gas-filled tube but is shunted around it.

In Figure 21, the heating coil 63 may be eliminated and the thermo-electrode 2 so constructed that it will act in a somewhat similar capacity; that is to say, the incoming line wire is connected to the lead-in wire 64, while the lead-in wire 5 is connected to ground, and the lead-in wire 64 is connected to a flexible wire 79, the opposite end of which is connected to the free end of the electrode 2. Preferably the wire 79 is of good conducting material such as copper. In this arrangement any "sneak" current coming in over the lead wire 64 and the flexible wire 79 to the instrument via lead 4, will heat the electrode 2, causing it to flex and contact with the ground electrode 3, thereby shunting the "sneak" current away from the instrument.

By having an arc gap positioned intermediate the ends of the electrodes, or nearer the fulcrum or the point about which the electrodes move, the heat generated by the current jumping this gap will more rapidly heat up the electrodes and cause them to flex and close the gap contacts,

than where the gap contact is at the extremity of the electrode. By getting this quick action or movement of the electrodes, the tendency for the arc to melt the metal of the electrodes is thereby greatly reduced. This arrangement also provides that if the voltage causes the current to jump at the closer gap, for example the gap 20 in Figure 9, the movement of the electrodes toward each other will start closing the gap 21 and the high voltage current will then find another path between the electrodes, thereby preventing all the current from passing between the electrodes at one point and consequently reducing the tendency to melt or destroy the electrodes. Thus the effect of the multiple gap arrangement between the electrodes is to quench the arc more rapidly and to dissipate the destructive effect of the arc.

While I have shown in various figures the sealed tube as a separate unit, it is to be understood that in each case the tube may be enclosed in a housing similar to that shown in either Figures 19 or 12, or any other desired form.

From what has been said, it will be observed that the details for carrying my invention into practice may be varied over a considerable range, and I therefore do not wish to be unduly limited in the interpretation of the appended claims.

What I claim is:

1. A protective device of the class described including, a sealed tube filled with an inert gas such as neon, a pair of bi-metallic electrodes mounted in spaced relation within the tube, each of said electrodes having a plurality of definite predetermined portions forming arc gaps for the passage of current therebetween.

2. A protective device as set forth in claim 1, further characterized in that one set of said predetermined portions is normally closer together than any other set of said portions.

3. A protective device of the class described including, a sealed tube, at least one bi-metallic electrode having an arc gap surface to engage another arc gap surface within said tube, and positive means including an outwardly bent end of said electrode which normally engages the inner wall of said tube for positioning the free ends of said electrode within the tube so as to prevent said arc gap surfaces from normally taking a position other than a given predetermined distance said bi-metallic electrode having another arc gap surface intermediate its ends and a further arc gap surface within said tube to cooperate with said intermediate electrode surface.

4. A protective device of the class described including, a sealed tube containing an inert gas, and quick arc extinguishing means within said tube comprising bi-metallic electrodes having an initial arc gap for carrying the arc current, and positive means including integral parts of said electrodes and the wall of said tube for preventing said initial arc gap from normally taking a position other than a predetermined distance and means for accelerating the speed of movement of said bi-metallic electrodes to close said arc gap as soon as possible after the discharge of current across the electrodes.

5. A protective device of the class described including, a sealed tube containing an inert gas, quick arc-extinguishing means within the tube comprising bi-metallic electrodes having at least a defined air gap intermediate their ends as well as a positively fixed initial gap at their free ends, which gap is greater than the intermediately positioned gap for the purpose described.

6. A protective device of the class described in-

cluding, a sealed inert gas tube, arc gap parts spaced in cooperative position within the tube, at least one of said arc gap parts being a bi-metallic thermostatic element, means for preventing said arc gap parts from normally taking a position other than a predetermined distance, and auxiliary bi-metallic members so positioned externally of the sealed tube and electrically connected to said arc gap parts to automatically shunt at least the greater part of said arc gap parts on passage of sufficient heat from the tube to said parts.

7. A lightning arrester comprising a container and electrodes normally separated by a gap, at least one of said electrodes being bi-metallic, the electrodes being relatively movable toward each other in response to the passage of current through the gap, and thermally responsive means carried by said container for automatically increasing the current-carrying capacity of the arrester by shunting current around said electrodes.

8. A protective device of the class described including a sealed tube filled with an inert gas, such as neon, a pair of bi-metallic electrodes mounted in spaced relation within the tube forming at least one arc gap, the electrodes being movable toward each other in response to the passage of current through the gap, and thermally responsive means carried by said container for automatically increasing the current-carrying capacity of the protective device by shunting current around said electrodes.

9. A lightning arrester comprising a container and electrodes normally separated by a gap, the electrodes being relatively movable toward each other in response to the passage of current through the gap, and thermally responsive means carried by said container for automatically increasing the current-carrying capacity of the arrester and speeding up the time of quenching the arc by shunting current around said electrodes.

10. A protective device of the class described

including a sealed tube filled with an inert gas, such as neon, a pair of bi-metallic electrodes mounted in spaced relation within the tube forming at least one arc gap, the electrodes being movable toward each other in response to the passage of current through the gap, and thermally responsive means carried by said container for automatically increasing the current-carrying capacity of the protective device, and at the same time speeding up the time of quenching the arc by shunting current around said electrodes.

11. A lightning arrester having at least a pair of spark gap elements, one of which at least has thermostatic characteristics, and also having a free end with a contact-engaging surface thereat, said elements having means intermedie therebetween whereby the heat, generated by said current at said means, acts to flex at least the element having the thermostatic characteristics to cause the contact at the free end to engage a part of the other gap element.

12. A protective device of the class described including a sealed chamber supporting therein at least a pair of spark gap elements, at least one of which has thermostatic characteristics and both having free ends with contact-engaging surfaces thereat and means for accelerating the speed of movement of the thermostatic element, said means comprising primary arc gap contacts on said elements between the end contacts and the support for the elements; said initial gap being smaller than the gap at the free ends of said elements to initiate the first discharge whereby heat will be generated nearer the central portions of said elements, thereby speeding up the operation of the thermostatic element and at the same time preventing, by the speeding up action, the burning of the end contact surfaces of said elements.

LEON S. BRACH