June 16, 1959 D. D. McSTRACK ET AL 2,891,194

OVERVOLTAGE PROTECTIVE DEVICE

Filed March 25, 1958

Fig. 1

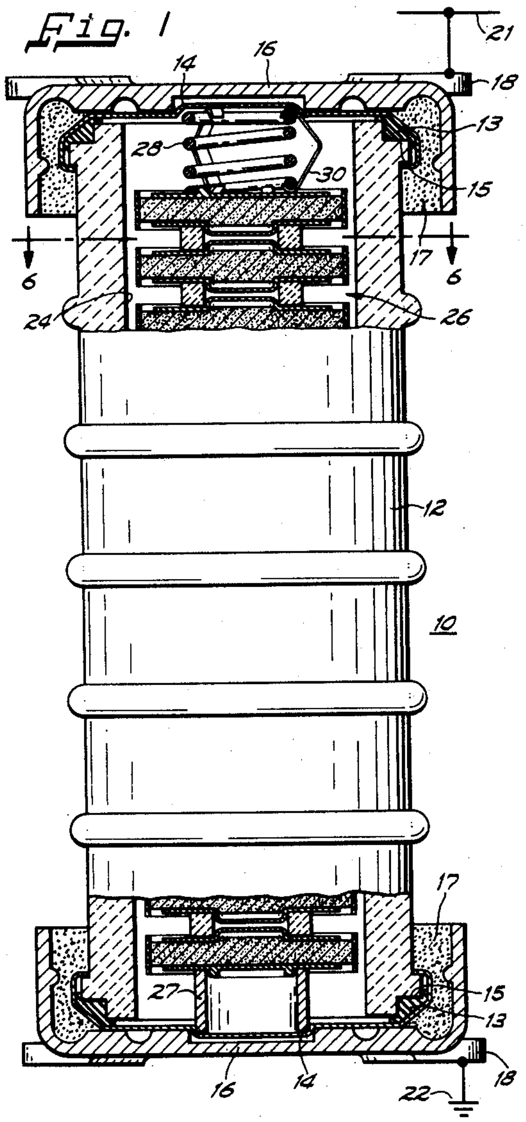


Fig. 3

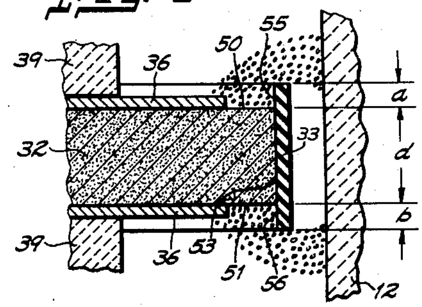


Fig. 4

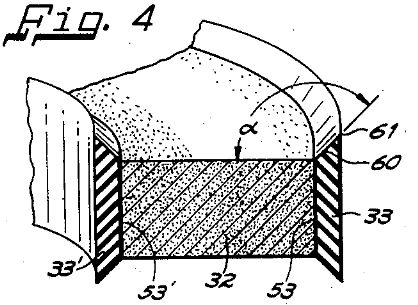


Fig. 5

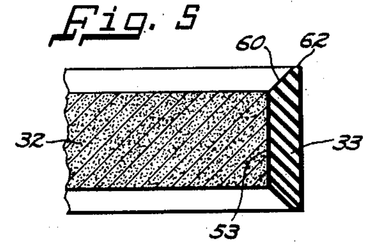


Fig. 6

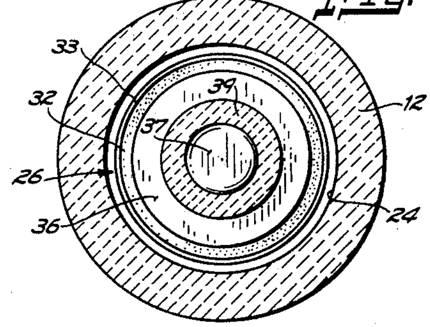
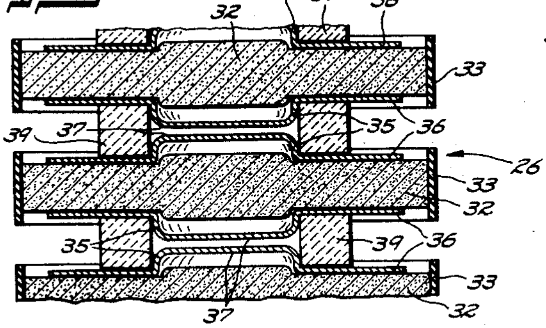


Fig. 2



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OVERVOLTAGE PROTECTIVE DEVICE

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15 Claims. (Cl. 315—36)

This invention relates to improvements in a valve-type excess voltage protective device and more particularly to an improved valve-type resistor or valve block for a lightning arrester and the method of manufacturing said valve block.

Valve-type excess voltage protective devices include a resistance element having non-linear voltage characteristics whereby it presents a low resistance to surge currents and a high resistance to the normal power current of the system. This resistance element is commonly called a valve block and the resistance material from which it is made is called valve material. Protective devices of this type are usually disposed between electric lines and ground and are designed to pass surge or transient currents when voltages in excess of prescribed levels are impressed across them and to interrupt the power follow current when the voltage decays to the rated value of the device.

The valve block of a valve-type excess voltage protective device may be series connected to a spark gap which electrically isolates the line from ground and is designed to break down and conduct current when a sufficiently high voltage, incident to a current surge, is applied to the device. Because of the non-linear resistance characteristics of the valve block, it readily passes the surge current and then restores the system to its normal operating condition, after the voltage across the device has returned substantially to the line voltage of the system, by limiting the follow current to a value which can be interrupted by the gap. In a second variety of valve-type excess voltage protective device, spark gaps are not utilized, the valve element being capable of passing surge currents readily and restricting power current to low values which the resistor is capable of carrying continuously.

In the type of protective device hereinafter disclosed, the resistor includes a series of cylindrical resistor blocks composed of granulated material, such as silicon carbide, and a suitable, substantially non-conductive, binding material. Adjacent blocks have flat contact surfaces face to face and metallic contact elements are disposed on the flat contact faces of each block. A suitable insulating material is generally applied to the cylindrical peripheral side surface of each of the valve blocks to minimize the possibility of flashover between contact elements which would electrically bypass the valve block.

When current flows between a valve block and the contact elements thereon, it generally takes multiple paths through the individual particles of valve material, and in the event of high current density some of the conductive material adjacent the contacts may be vaporized. This vaporized contact material and its attendant ionized gas shoot out along each of the contact faces. Due to a phenomenon known as the Coanda effect wherein a stream of gas moving rapidly over a surface tends to follow deviations therein, the vaporized particles and ionized gas moving rapidly over each of the contact faces of the valve block tend to turn at the periphery of each face and move

along the side surface toward the opposite contact face. These converging clouds of ionized particles and vaporized metal provide a short circuit path around the valve block, whereby the follow current limiting effect of the block is lost. Heretofore, it has been the practice to coat the peripheral surface of the blocks with insulation, the edges of which terminate in planes more or less coinciding with the planes of the contact faces of the blocks. However, due to the phenomena noted, this insulation did not prevent or deter convergence of the ionized gas streams around the peripheral edges of the blocks.

Prior art methods of applying surface insulation to the periphery of a preformed block of valve material generally included at least one of the steps of painting, roll coating, or spraying of the insulating material, which was a liquid or a solid suspended in a liquid, onto the valve block, and further entailed the step of curing or firing the insulation after the application thereof. Such methods required expensive machinery and necessitated expensive precautionary measures to prevent contamination of the assembly area and to safeguard the health of the workers.

Another method employed in the prior art involved the insertion of valve material into a rigid preformed ring of insulating material, usually a ceramic. This method included the steps of pressing the valve material into the insulating ring and then firing the block so formed in order to bond the valve material to the ring. Such method of applying surface insulation was not wholly satisfactory both because it was costly and because the two materials may shrink at different rates, making positive bonding therebetween difficult and inducing stresses in the valve block. Also, valve blocks having such nonflexible surface insulation were highly suceptible to damage during shipment and handling.

An object of the invention is to provide a new and improved valve block for valve-type lightning arrestors.

A further object is to provide a new and improved valve block having surface insulation which will prevent flashover due to the Coanda effect and increase the leakage distance between the contact faces of the block.

More specifically, it is an object of the invention to provide a valve block or disc having a marginal insulating barrier which diverts ionized gas angularly away from the planes of the contact surfaces and thus prevents flashover between the contact surfaces.

Another object is to provide a new and improved valve block having peripheral surface insulation which is easy to apply and bonds readily with said valve block.

Still another object is to provide a method of applying valve block surface insulation which does not require curing or firing and does not involve a hazard of health to the workers.

A still further object is to provide a valve block having surface insulation which cushions the valve block against shock during assembly and shipment.

Other objects and advantages of the invention will be apparent from the following detailed description, taken in connection with the accompanying drawings in which:

Fig. 1 is an elevational view, partly in section, of a valve-type lightning arrester embodying novel valve means in accordance with the invention;

Fig. 2 is an enlarged fragmentary view, partly in section, of arrester elements embodying the invention;

Figs. 3, 4 and 5 are fragmentary views, partly in section, illustrating alternative embodiments of the invention; and

Fig. 6 is a sectional view taken along line **6—6** of Fig. 1.

The objects of one aspect of the invention are accomplished by a valve block having a pair of opposed contact face portions and electrical insulating means surrounding the block and extending beyond the plane of at least one of said contact face portions. The insulating means provides a continuous peripheral barrier of insulating material around the block and beyond the plane of said contact face portion, thus presenting a relatively long leakage distance and serving to diverge the clouds of vaporized conductive material and ionized particles emanating from the opposite sides of the valve block and preventing the formation of a continuous arc path between the contact faces of the valve block. The barrier insulation is preferably of a resilient or shock resistant material and is to provide a protective buffer for the valve block during handling and shipment.

In another aspect the objects of the invention are accomplished by forming a block of valve material having a pair of contact faces on opposite sides thereof and a peripheral surface having its margins defined by said contact faces, applying an insulating material in the dry state to the peripheral surface and extending the insulating material beyond each of the intersections between the peripheral surface and the contact faces to form a continuous barrier of insulating material around each of said contact faces. The application of insulating material in dry form eliminates the inherent mess, expensive machinery, and the drying of firing step associated with applying insulation in the liquid form and further removes all hazard of health to the workers.

Referring now to the drawings in greater detail, Figs. 1 and 6 show a lightning arrester **10** comprising a cylindrical housing **12** of a suitable insulating material, such as porcelain or glass closed at its ends by cup-shaped end caps **14** and hermetically sealed by resilient annular gasket **13** compressed by end caps **14** against annular seats **15** provided in the outer periphery of each end of housing **12**. A terminal cap **16** of electrical conducting material such as aluminum is secured to each end of the housing **12** by any suitable means **17** such as cement. The caps **16** are provided with terminal lugs **18** for mounting of the arrester and electrical connection at one end of the arrester with the electrical power system **21** to be protected and at the other end with ground **22**. The bore **24** of the housing **12** contains a stack of arrester components **26** which are maintained in electrically conductive relationship with each other by a compression spring **28** which engages the upper end of the stack and urges the lower end of the stack of components against a hollow cylindrical spacer member **27** of suitable conductive material such as aluminum. A conductive shunt **30** is disposed between the upper closure cap **14** and the upper arrester component **26** of the stack to insure good electrical connection therebetween and to relieve the spring **28** of undesirable current flow.

The arrester components **26**, shown in greater detail in Fig. 2, each comprises a block of valve material **32** preferably of cylindrical configuration having relatively spaced contact faces **50** and **51** peripherally surrounded by insulation **33** in accordance with the invention which will be discussed in greater detail hereinafter. Each of the blocks **32**, except those at each end of the stack, has its opposed faces **50** and **51** in contact with dished gap electrodes **35** each having an outer planar portion **36** and an embossed central portion **37**, the planar portion of each gap electrode **35** being held in contact with one side **50** and **51** of the valve block **32** in a manner well known in the art and the embossed portions **37** of the electrodes on adjacent blocks **32** forming the electrodes of a spark gap. Voltage dividing or equalizing resistor rings **39** are disposed between opposed electrodes **35** on adjacent valve blocks. It is understood that the configuration of the gap structure shown herein is merely intended as an example, the valve blocks according to the invention operating equally well in lightning arresters having different configurations of electrodes, spark gaps, and resistor rings. It is also understood that the valve blocks according to the invention may be employed in excess voltage protective devices not utilizing spark gaps.

Referring now to Fig. 3, the resistor according to the invention includes a block **32** composed of granulated valve material, such as silicon carbide, and essentially nonconductive binding material and is preferably of a generally cylindrical configuration having a pair of end, or contact, faces **50** and **51** and a cylindrical side surface **53** connecting the end faces. The insulation **33** covers the surface **53** and extends beyond the plane of each face **50** and **51** in a direction generally normal thereto to form a continuous peripheral barrier, or ridge, **55** and **56** of insulating material around each of the end faces. While peripheral ridges **55** and **56** are shown to be perpendicular to contact faces **50** and **51**, they may be formed at acute or obtuse angles to said faces without materially reducing the gas deflecting efficiency of the ridges.

In operation, when current passes between the planar portions **36** and through the valve block **32**, it generally takes a number of parallel paths from the electrode surface to the individual particles of valve material. These paths may have very high current density and may cause some of the electrode material to become vaporized which, together with its accompanying ionized gas, may shoot out along the contact faces **50** and **51** of the block. The peripheral ridges **55** and **56** will deflect the vaporized conductive particles and ionized gas upwardly and downwardly respectively of the valve block, thus preventing the formation of the gas streams into a conducting path around the block due to the Coanda effect. It is understood that flashover prevention could be achieved, although to a lesser degree of efficiency, by the use of a single peripheral barrier around one of the contact faces **50** and **51**, whereby one of the gas clouds would be diverted away from the opposite face of the valve block.

In one embodiment of the invention, the surface insulation **33** is composed of an insulating tape which is preferably of the pressure sensitive variety. The tape **33** has a greater width than the axial thickness of the valve block **32** between the contact faces **50** and **51**, the intermediate portion *d* of the insulating tape being disposed on and in intimate contact with the peripheral surface **53**, whereby edge portions *a* and *b* of the tape extend beyond the adjacent margins of the peripheral surface **53** and the edges of face portions **50** and **51**, respectively, thereby providing continuous peripheral barriers **55** and **56** of insulation around the face portions **50** and **51** respectively. In alternative embodiment, the surface insulation **33** may comprise a preformed ring of resilient or shock resistant insulating material such as phenolic or epoxy resins, ductile ceramic, or the like. While contact faces **50** and **51** are shown to be planar, it is understood that they can take any convenient form.

The overvoltage protective device shown in Fig. 3 may be manufactured by molding a valve material and a suitable binder into a generally cylindrical block **32** having a predetermined thickness between the end faces **50** and **51**. A length of insulating material **33**, such as insulating tape having a predetermined width *a* plus *b* plus *d* greater than the thickness *d* of the valve block **32**, is selected and the intermediate portion *d* thereof is applied to the cylindrical surface **53** of the valve block **32** while the edge portions *a* and *b* of the insulating material are extended beyond the planes of each of the face portions **50** and **51**.

An overvoltage protective device according to the invention may also be formed by selecting a tubular insulating member **33** having an axial length greater than the thickness of the valve block **32**. The tubular insulating member **33** is placed around the block **32** so that portions **55** and **56** of said member extend beyond each of the face portions **50** and **51** of the valve block **32** and the tubular member **33** is then shrunk onto said block **32**, forming a peripheral barrier of insulating material around each face portion **50** and **51**. Another method of applying the surface insulation 33 may comprise molding a resinous insulating material to the peripheral surface 53 of the block 32 and extending the insulating material beyond the contact faces 50 and 51. In the disclosed methods of forming the peripheral barriers 55 and 56 the insulating material is preferably in dry form, i.e., not in the liquid state and not suspended in a liquid, and thus no health hazard is involved and no curing or firing cycle is required.

If, as in Fig. 4, the radial thickness of the insulation 33 is equal to or greater than the distance which insulation 33 extends beyond the contact faces 50 or 51, the inside surface 60 and 60′ of the peripheral barriers 55 and 56 should preferably be beveled outwardly at an angle α and of no greater than 135° to the plane of the adjoining contact face on the block so that the gas cannot form parallel to the upper edge of the insulation 33 and thus the Coanda effect cannot come into play. Although angles greater than 135° will be operative, an angle α increases from 135° to 180°, the efficiency of the peripheral barrier in preventing flashover due to the Coanda effect decreases. Although the sharp edge 61 shown in Fig. 4 is preferable, it is often difficult to construct and may make handling dangerous, so that it is permissible to form a land 62 on the ridge as illustrated in Fig. 5, provided that the width of the land 62 is kept small with respect to the height of the peripheral ridge 55 or 56.

It is understood that the disposition of surface insulation according to the invention is dictated by the configuration of the valve block to which it is applied, that is, all the edges of the contact faces over which flashover can occur are preferably provided with a peripheral barrier. For example, the annular valve block 32 of Fig. 4, having outer peripheral surface 53 and inner peripheral surface 53′, each of which connects contact faces 50 and 51, would preferably be provided with surface insulation 33′ on inner surface 53′ as well as surface insulation 33 on outer surface 53.

While only a few embodiments of the invention have been illustrated and described, many modifications and variations thereof will be obvious to those skilled in the art, and consequently it is intended in the appended claims to cover all such modifications and variations which fall within the true spirit and scope of the invention.

We claim as our invention:

1. In an overvoltage protective device, the combination of a block of valve material having a pair of opposed face portions and at least one surface defining margins of said face portions and disposed therebetween, electrical insulation comprising a resilient material secured to and in intimate contact with said surface and projecting beyond at least one of said face portions in a direction generally transverse thereto said insulation defining a continuous peripheral barrier of insulating material around said face portion.

2. In an overvoltage protective device, the combination of a block of valve material having a pair of opposed face portions and a peripheral surface surrounding said face portions and defining the margins thereof, and electrical insulation secured to and in intimate contact with said peripheral surface and around the marginal edges of said faces, said insulation covering said peripheral surface and having a greater width than the width of said block between said face portions, the marginal portions of said insulation projecting beyond each of said face portions in a direction generally transverse thereto to define a continuous peripheral barrier of insulating material around each of said face portions, said insulation being of a resilient material.

3. An overvoltage protective device as set forth in claim 2 in which said electrical insulation comprises a resinous material.

4. An overvoltage protective device as set forth in claim 2 in which said electrical insulation comprises a ductile ceramic material.

5. In an overvoltage protective device, the combination of a block of valve material having a pair of opposed face portions and a peripheral surface surrounding said face portions and disposed therebetween, electrical insulating means secured to and covering said surface and extending in a direction generally transverse to and beyond the edge of each of said face portions to define a continuous peripheral ridge of electrical insulating means around each of said face portions, the thickness of said insulating means being at least of the same order of magnitude as the height of the peripheral ridge, the inner surface of said peripheral ridges forming an angle of less than 180° relative to the face portions of the block.

6. An overvoltage protective device as set forth in claim 4 wherein a land is provided at the edges of said insulating means between the outer surface of the insulation and the inner surface of the ridge.

7. In an overvoltage protective device, the combination of resistance means having valve characteristics, said resistance means having a pair of opposed face portions and a peripheral surface terminating in said face portions and disposed therebetween, and electrical insulating tape disposed on said surface and extending around said face portions, a portion of said insulating tape projecting beyond at least one of said face portions in a direction generally transverse thereto to provide a continuous barrier of insulation therearound.

8. In an overvoltage protective device, the combination of a block of valve material having a pair of opposed face portions, said valve block having a peripheral surface extending around said block and disposed between said face portions, said peripheral surface having its margins defined by said face portions, and electrical insulating tape having a greater width than the width of the said block between said face portions, said insulating tape being disposed on said surface and around the periphery of said face portions, the intermediate portion of insulating tape engaging said surface and a portion of said greater width extending beyond each of said face portions in a direction generally transverse thereto in the form of a continuous peripheral barrier of insulating material around each of said face portions.

9. In an overvoltage protective device comprising a plurality of valve discs and spark gaps in alternate stacked relation, in combination, a valve disc having opposed contact faces and a peripheral surface therebetween, a pair of gap electrodes each in contact with one of said faces on a side opposite that of the other, and electrical insulation disposed around the peripheral surface of said discs and in intimate contact therewith, said insulation being of a width greater than the distance between said contact faces and intersecting and extending beyond each of said contact faces, said insulation comprising a resilient material.

10. The method of manufacturing a resistance element comprising the steps of forming a block of resistance material having a pair of opposed face portions and at least one peripheral surface disposed therebetween and defining the margins thereof, applying a dry insulating material to and covering said peripheral surface, and extending the insulating material beyond at least one of said face portions in a direction generally transverse thereto to form a continuous barrier of insulating material around said face portion.

11. The method of manufacturing a resistance element having valve characteristics comprising the steps of forming a block of valve material having a pair of opposed face portions disposed a predetermined distance therebetween and a peripheral surface surrounding said face portions and disposed therebetween, selecting a band of electrical insulating material having a predetermined width greater than the distance between said opposed

faces, and applying an intermediate portion of said band to said surface so that the marginal portions of said band adjacent said intermediate portion extend beyond each of said face portions in a direction generally transverse thereto to form a barrier of insulating material around each of said face portions.

12. The method of manufacturing a resistance element having valve characteristics comprising the steps of forming a block of valve material having a pair of opposed face portions and a peripheral surface disposed therebetween and defining the marginal edges of said face portions, selecting electrical insulating tape having a greater length than the peripheral length of said surface, and applying said insulating tape to said surface to cover said surface between said face portions.

13. A method of manufacturing a resistance element having valve characteristics, comprising the steps of forming a block of valve material having a pair of opposed face portions disposed a predetermined distance therebetween and a peripheral surface surrounding said face portions and disposed therebetween, selecting a length of electrical insulating tape having a predetermined width greater than the distance between said opposed faces, applying an intermediate portion of said tape to said surface so that the marginal portions of said tape adjacent said intermediate portion extend beyond each of said face portions in a direction generally transverse thereto to form a barrier of insulating material around each of said face portions.

14. The method of manufacturing a resistance element having valve characteristics, comprising the steps of forming a block of valve material having a pair of relatively spaced opposed face portions and a peripheral surface defining the margins of said face portions and disposed therebetween, applying resinous insulating material on said surface and molding said resinous insulating material to form a continuous barrier of insulating material peripherally around each of said face portions.

15. In an overvoltage protective device, the combination of a block of valve material having a pair of opposed face portions and a peripheral surface surrounding said face portions and defining the margins thereof, and electrical insulation extending around said peripheral surface and covering a portion thereof, said insulation being of a resilient material.

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