United States Patent [19]

Person

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[54] **SURGE ARRESTOR**

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[73] Assignee: **Dale Electronics, Inc.**, Columbus, Nebr.

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[52] **U.S. Cl.** **317/61.5**; 317/62; 317/74; 317/77; 313/54; 313/220

[51] **Int. Cl.**..... **H02h 1/04**; H02h 3/22

[58] **Field of Search** ..... 313/54, 155, 214, 217, 313/220, 308, 309, 325; 317/61, 66, 67, 68, 69, 70, 71, 72, 73, 74, 77, 256, 242, 61.5; 315/150, 183, 59 X, 59

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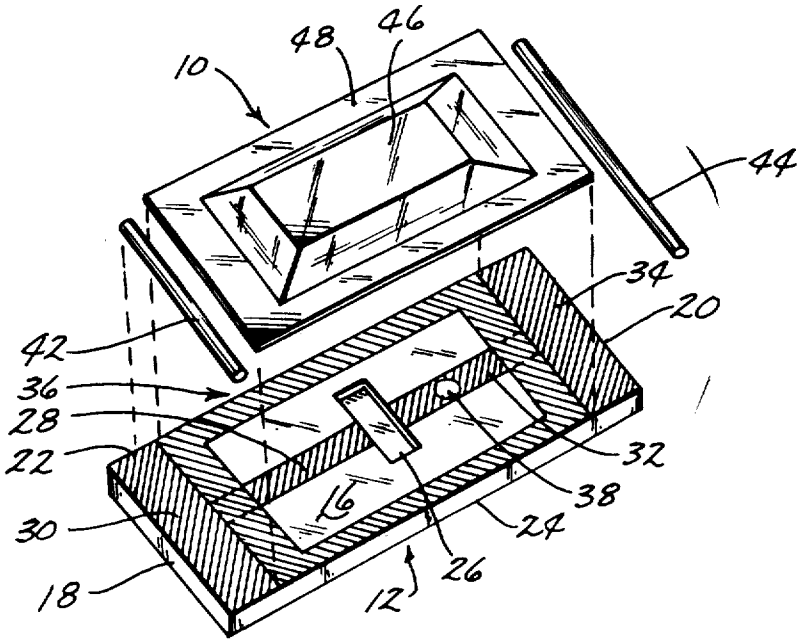
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Primary Examiner—J. D. Miller
Assistant Examiner—Patrick R. Salce
Attorney, Agent, or Firm—Zarley, McKee, Thomte & Voorhees

[57] **ABSTRACT**

A surge arrestor comprising a flat ceramic substrate having a centrally disposed notch formed in the upper surface thereof. First and second electrodes are provided on the upper surface of the substrate and extend from opposite sides of the notch to the outer ends of the ceramic substrate. First and second leads are secured to the outer ends of the first and second electrodes respectively. A glass cover is secured to the upper surface of the substrate material between the electrodes and extends over the notch to define a spark gap compartment. The spark gap compartment is filled with a suitable radio-active gas such as Kr-85 and argon. Modified forms of the arrestor are also disclosed having various spark gap configurations.

13 Claims, 8 Drawing Figures



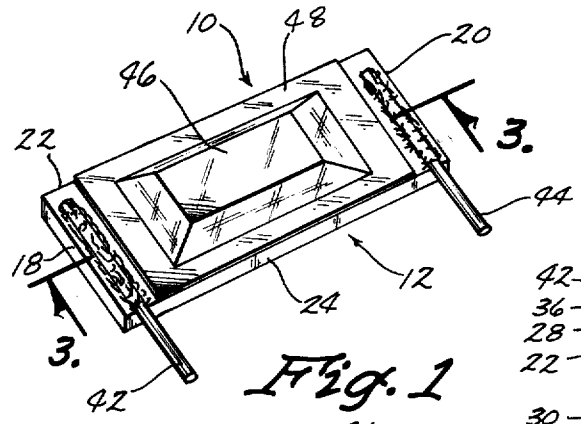


Fig. 1

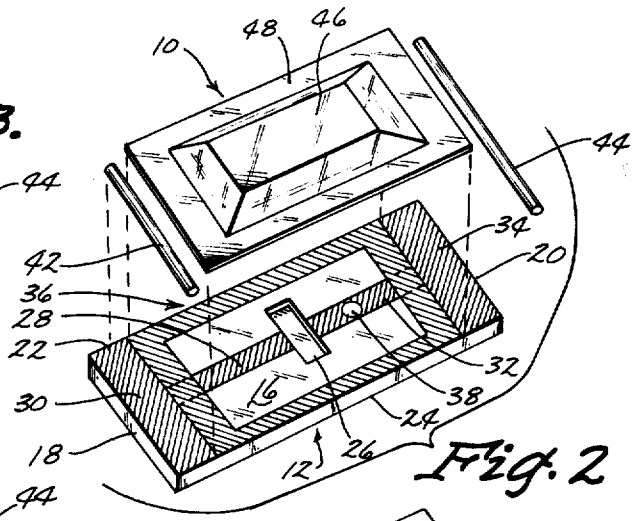


Fig. 2

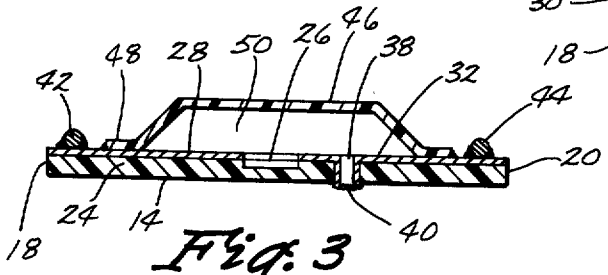


Fig. 3

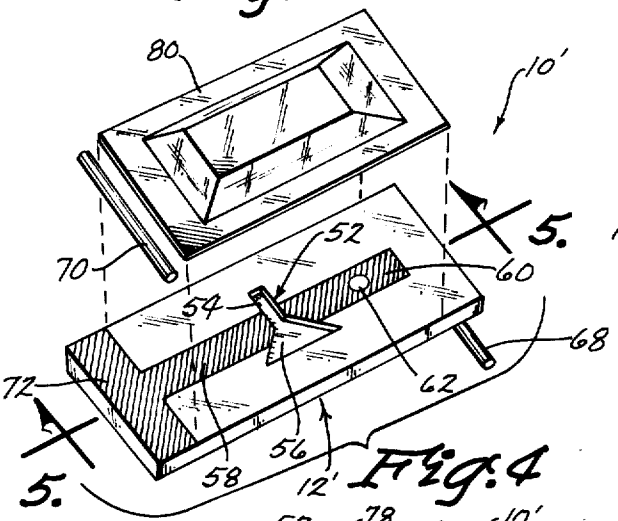


Fig. 4

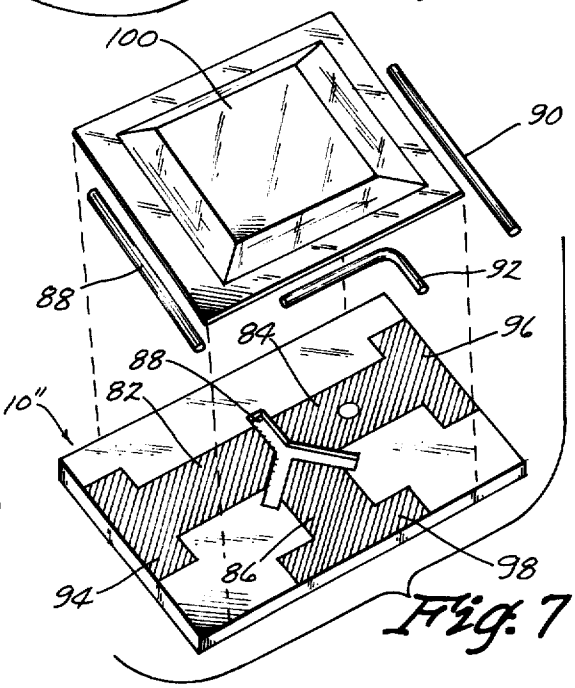


Fig. 7

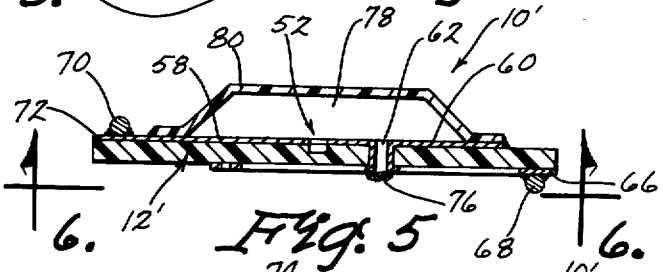


Fig. 5

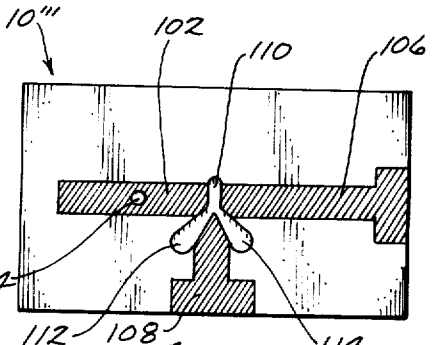


Fig. 8

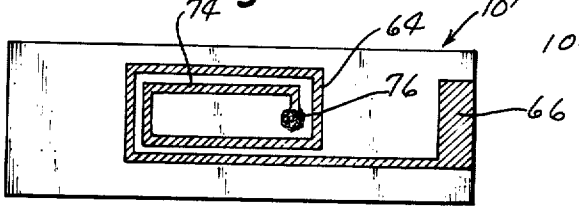


Fig. 6

SURGE ARRESTOR

BACKGROUND OF THE INVENTION

This invention relates to a surge arrestor and more particularly to a surge arrestor which is substantially flat and which occupies a minimum amount of space. Conventional spark arrestors are ordinarily tubular in shape and do not easily lend themselves to automatic production methods. Additionally, the tubular surge arrestors of the prior art are fairly large and are not easily installed on printed circuit boards. Additionally, the surge arrestors of the prior art have a shunt capacitance of approximately 2pf.

Therefore, it is a principal object of the invention to provide an improved surge arrestor.

A further object of the invention is to provide a surge arrestor which may be constructed by using thick film technology.

A further object of the invention is to provide a surge arrestor which may be produced with automated equipment.

A further object of the invention is to provide a surge arrestor which may be fabricated from inexpensive materials.

A further object of the invention is to provide a surge arrestor which is substantially flat to enable it to be employed on printed circuit boards.

A further object of the invention is to provide a surge arrestor which has an extremely small shunt capacitance.

A further object of the invention is to provide a surge arrestor which may be employed in high frequency circuits without disrupting the characteristics of the circuits.

A further object of the invention is to provide a surge arrestor having improved operating characteristics.

A further object of the invention is to provide a surge arrestor having a glass cover disposed over the spark gap to enable the interior of the surge arrestor to be inspected.

A further object of the invention is to provide a surge arrestor which is durable in use.

These and other objects will be apparent to those skilled in the art.

BRIEF DESCRIPTION OF THE DRAWINGS

This invention consists in the construction, arrangements and combination of the various parts of the device, whereby the objects contemplated are attained as hereinafter more fully set forth, specifically pointed out in the claims, and illustrated in the accompanying drawings, in which:

FIG. 1 is a top perspective view of the surge arrestor of this invention:

FIG. 2 is an exploded perspective view of the surge arrestor of FIG. 1:

FIG. 3 is a sectional view taken on lines 3 — 3 of FIG. 1:

FIG. 4 is an exploded perspective view of a modified form of the arrestor:

FIG. 5 is a sectional view taken on lines 5 — 5 of FIG. 4:

FIG. 6 is a bottom view of the arrestor of FIG. 5 as seen on lines 6 — 6 of FIG. 5:

FIG. 7 is an exploded perspective view of another form of the arrestor; and

FIG. 8 is a top view of a still farther modified form of the arrestor with the glass cover removed therefrom to more fully illustrate the invention:

DESCRIPTION OF THE PREFERRED EMBODIMENT

The surge arrestor of FIGS. **1, 2** and **3** is referred to generally by the reference numeral **10.** Arrestor **10** comprises a flat ceramic substrate material **12** having a bottom surface **14,** top surface **16,** opposite ends **18** and **20,** and opposite sides **22** and **24.**

The numeral **26** refers to a rectangular spark gap notch which is formed in the central area of substrate material **12** and which has it longitudinal axis disposed transversely to the longitudinal axis of the substrate material **12.** The numeral **28** refers to an electrode which is screen printed on the top surface of substrate material **12** and which extends towards end **18** as seen in FIG. **2.** The outer end of electrode **28** is provided with a pad portion **30.** An electrode **32** is screen printed on the upper surface of substrate material **12** and extends towards the end **20** as illustrated in FIG. **2.** Electrode **32** is provided with a pad portion **34** at its outer end. As seen in FIG. **2,** the inner ends of the electrodes **28** and **32** terminate on opposite sides of the notch **26.**

The numeral **36** refers to a screen printed seal material which is provided on the upper surface **16** of substrate material **12** as depicted in FIG. **2.** It can be seen in FIG. **2** that the opposite ends of the seal material **36** are positioned inwardly of the pad portions **30** and **34.** A gas hole **38** extends through the substrate material **12** as illustrated in FIG. **3.** The gas hole **38** is formed in the substrate material **12** prior to the electrode material being screen printed on the substrate material **12** so that the electrode material will flow downwardly into the hole **38** to be deposited on the walls defining the hole **38.** The numeral **40** refers to a soft solder plug which is installed in the lower end of the gas hole as will be explained in more detail hereinafter.

Tin plated copper wires **42** and **44** are soldered to the pad portions **30** and **34** respectively and would be connected to the circuit in which the arrestor is installed. A transparent glass cover **46** is secured to the upper surface **16** of substrate material **12** by means of the screen printed seal material **36.**

The method of assembling the arrestor **10** is as follows. The notch **26** is formed in the ceramic substrate material **12** and the hole **38** formed in the material **12** if the hole has not been previously formed. The electrodes **28** and **32** are screen printed on upper surface **16** and would be comprised of a thick film ink or other suitable material. The seal material **36** is then screen printed on the upper surface **16.** The seal material **36** would preferably be comprised of a glass frit material mixed with an oil base paint. Seal material would also be provided on the underside of the periphery **48** of cover **46.** The cover **46** is then placed onto the seal material **36** and the surge arrestor placed in an oven having a temperature of approximately 450° to 480°C to seal the cover **46** to the substrate material **12.**

The leads **42** and **44** are then soldered to the pad portions **30** and **34.** The surge arrestor is then placed in a vacuum chamber so that the compartment area **50** is evacuated. The compartment area **50** is then filled with an inert gas containing a radio-active isotope or the

like. The soft solder plug **40** is then positioned in the hole **38** to seal the compartment area **50.**

In operation, the surge arrestor **10** would be connected to any circuit requiring an arrestor. If a surge of predetermined magnitude should be experienced by the circuit, an arc will occur between the electrodes **28** and **32** in the spark gap notch **26** rather than on the surface of the substrate material **12.** The shunt capacitance between the electrodes is very low which permits it to be used in high frequency circuits such as cable television or the like. The low shunt capacitance is provided because only small areas of adjacent electrodes confront each other. Prior art surge arrestors have a shunt capacitance of 2 pf whereas the surge arrestor **10** would have a shunt capacitance of less than 1 pf. This means that the surge arrestor **10** could be used in low level circuits where frequency is up to 1,000 Hz.

The flat construction of the arrestor permits it to be used on printed circuit boards since it occupies very little space. The major advantage of the surge arrestor **10** is that it can be produced by using thick film technology which means that it can be made on automatic equipment and with inexpensive materials. The tubular prior art surge arrestors do not easily lend themselves to automated means. The transparent glass cover **46** permits the interior of the arrestor to be visually inspected to determine if the arrestor has experienced damage to its components. The flat construction of the surge arrestor allows several arrestors to be constructed on a single flat sheet of substrate material with the material then being broken along break lines to provide the individual surge arrestors. Thus it can be seen that the surge arrestor of FIGS. **1, 2** and **3** accomplishes at least all of its stated objectives.

The numeral **10'** refers to a modified form of the arrestor in FIGS. **4, 5** and **6.** A flat ceramic substrate material **12'** has a spark gap notch **52** formed in the central upper surface thereof as seen in FIG. **4.** Notch **52** comprises a rectangular portion **54** and a wedge shaped portion **56.** Electrode **58** is screen printed on the upper surface of the substrate material **12'** and has its inner end communicating with the notch **52.** Electrode **60** is also screen printed on substrate material **12** on the opposite side of the notch **52** and extends towards the other end of the arrestor as seen in FIG. **4.** A gas hole **62** extends through the substrate material **12'.** It can be seen that the material of the electrode **62** extends downwardly through the hole **62** to be in electrical contact with the electrode **64** which is screen printed on the bottom of the substrate material **12'.** Electrode **64** comprises a pad portion **66** to which a lead **68** is soldered. Lead **70** is soldered to the pad portion **72** of electrode **58.** Electrode **64** is screen printed on the bottom of the substrate material **12'** so as to define a coil portion **74.** The gas hole **52** is sealed with a soft solder plug **76** after the compartment area **78** beneath the glass cover **80** has been evacuated and filled with the inert gas. The arrestor **10'** is assembled in substantially an identical manner to arrestor **10.** In operation, the leads **68** and **70** are connected in series with the spark gap notch **52.** The arrangement of the coil **74** is such that the arc in the spark gap notch **52** will be blown into the open wedge portion **56** to direct the arc away from the inner ends of the electrodes to prevent the electrode material from burning which increases the life of the unit. The arrestor **10'** functions substantially identical to arrestor **10** except that arrestor **10'** is provided with a magnetic field producing coil which is connected in series with the spark gap to blow the arc into the open wedge as previously described.

The numeral **10''** refers to a surge arrestor in FIG. **7** which is substantially identical to the surge arrestors **10** and **1'** except that the surge arrestor **10''** is a three terminal surge arrestor. As seen in FIG. **7,** screen printed electrodes **82, 84** and **86** are disposed adjacent a Y-shaped notch or groove **88** formed in the substrate material. The leads **88, 90** and **92** would be soldered to the pad portions **94, 96** and **98** of electrodes **82, 84** and **86** respectively. The glass cover **100** is installed on the device as in the previously described arrestors.

In FIG. **8,** the numeral **10'''** refers to a surge arrestor which is of the three terminal type and which has a blow out coil connected in series with one of the terminals. A blow out coil similar to that shown in FIG. **6** would be provided on the underside of the substance material and would be in electrical contact with the screen printed electrode **102** through the gas hole **104.** The inner ends of screen printed electrodes **102, 106** and **108** communicate with a Y-shaped or fan-shaped spark gap notch **110** formed in the substrate material. Notch **110** includes two fan portions **112** and **114** as seen in FIG. **8.** If an arc should occur in the spark gap notch **110,** the magnetic field created by the blow out coil on the underside of the substrate material will cause the arc to be blown outwardly into the portions **112** and **114** to prevent the electrode material from being burned.

Thus it can be seen that an arrestor has been provided which accomplishes at least all of its stated objectives.

I claim:

1. A surge arrestor comprising,

a flat substrate material having a top surface and opposite ends, said substrate material having a spark gap notch formed in its top surface, a first electrode on said top surface extending from one side of said notch towards one end of said substrate material,

a second electrode on said top surface extending from the other side of said notch towards the other end of said substrate material,

first and second leads secured to said first and second electrodes respectively,

and a sealed cover means secured to said top surface extending over said notch, said cover means being secured at its periphery to said top surface and being positioned between said first and second leads.

2. The surge arrestor of claim **1** wherein said cover means is comprised of a transparent material.

3. The surge arrestor of claim **1** wherein said cover means is comprised of a transparent glass material.

4. The surge arrestor of claim **1** wherein said cover means has a dome portion which is spaced above the top surface of said substrate material to define a compartment area.

5. The surge arrestor of claim **4** wherein an inert gas is confined in said compartment area.

6. The surge arrestor of claim **1** wherein said electrodes are screen printed on said substrate material.

7. The surge arrestor of claim **1** wherein a seal material is screen printed on said top surface of said substrate material, said seal material sealably engaging the periphery of said cover means.

8. The surge arrestor of claim 1 wherein a third electrode is positioned on said top surface and extends from said notch, said notch being Y-shaped.

9. A surge arrestor comprising,

a flat substrate material having a top surface and opposite ends, said substrate material having a spark gap notch formed in its top surface, a first electrode on said top surface extending from one side of said notch towards one end of said substrate material,

a second electrode on said top surface extending from the other side of said notch towards the other end of said substrate material,

first and second leads secured to said first and second electrodes respectively,

a sealed cover means secured to said top surface extending over said notch,

said substrate material having an opening formed therein and extending therethrough, one end of said opening communicating with the interior of said cover means, said opening being provided to supply an inert gas material into the interior of said cover means, and a solder plug means in the other end of said opening to seal said opening.

10. The surge arrestor of claim 9 wherein said electrodes comprise a screen printed electrode material, at least some of said electrode material extending downwardly through said opening, said solder plug means being secured to the electrode material in said opening.

11. A surge arrestor comprising,

a flat substrate material having top and bottom surfaces opposite ends and opposite sides,

said substrate material having a spark gap notch formed in its top surface,

a first electrode on said top surface extending from one side of said notch towards one end of said substrate material,

a second electrode on said top surface extending from the other side of said notch towards the other end of said substrate material,

said substrate material having an opening formed therein and extending therethrough,

said second electrode extending downwardly through said opening to said bottom surface, said second electrode extending outwardly on said bottom surface towards said other end,

a first lead secured to said first electrode,

a second lead secured to said second electrode on said bottom surface adjacent said other end,

a sealed cover means secured to said top surface extending over said notch,

and means sealing said opening.

12. The surge arrestor of claim 11 wherein said notch comprises a rectangular portion and a wedge shaped portion at one end thereof, said second electrode on said bottom surface defining a blow-out coil so that a spark occurring in said rectangular portion will be blown into said wedge shaped portion away from said electrodes.

13. The surge arrestor of claim 11 wherein said notch comprises a rectangular portion having a pair of diverging notch portions extending from one end thereof, a third electrode on said top surface having one end positioned adjacent said notch between said diverging notch portions and extending towards one of said sides of said substrate material, said second electrode on said bottom surface defining a blow-out coil so that a spark occurring in said rectangular portion will be blown into said diverging notch portions.

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