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Flatt

[11] **3,884,542**

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[54] **PRESSURE ACTUATED ELECTRICAL BYPASS CIRCUIT FOR A HIGH VOLTAGE BUSHING**

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[73] Assignee: **RTE Corporation,** Waukesha, Wis.

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[52] **U.S. Cl.** ..... **339/111;** 200/144 C

[51] **Int. Cl.** **H01r 13/52**

[58] **Field of Search** ..... 339/111, 143 R, 143 T; 200/144 R, 149 A

[56] **References Cited**

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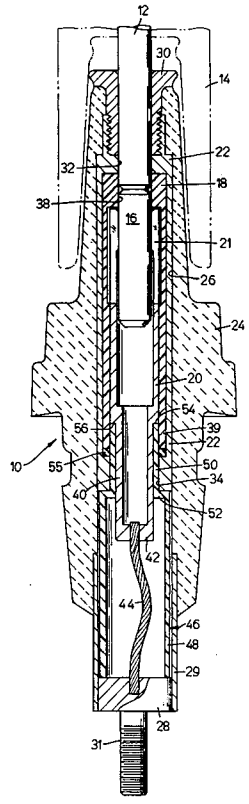
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Primary Examiner—Roy Lake
Assistant Examiner—DeWalden W. Jones
Attorney, Agent, or Firm—Ronald E. Barry

[57] **ABSTRACT**

A bushing having an electrical contact mounted within an insulating housing, the electrical contact being supported in a position to receive the electrically conductive probe on a high voltage terminator, an electrical bypass circuit element mounted in the housing for completing an electrical circuit between the probe and the electrical contact in the bushing whenever the pressure of the gas produced by the heat of the prestrike arc on fault close-in produces a sufficient force against the electrical contact to break a frangible member allowing the pressure of the gas to move an element rapidly away from the probe and into electrical engagement with the bypass member. A pressure responsive clamp is also provided in the bushing to clamp the probe in the bushing.

18 Claims, 4 Drawing Figures



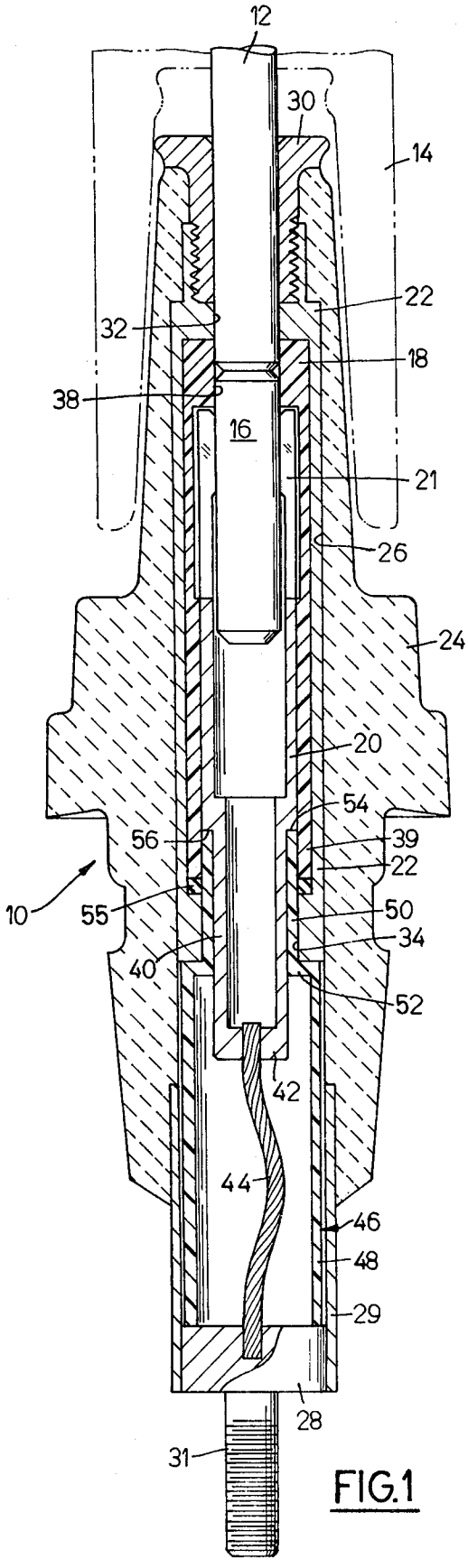

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FIG.1

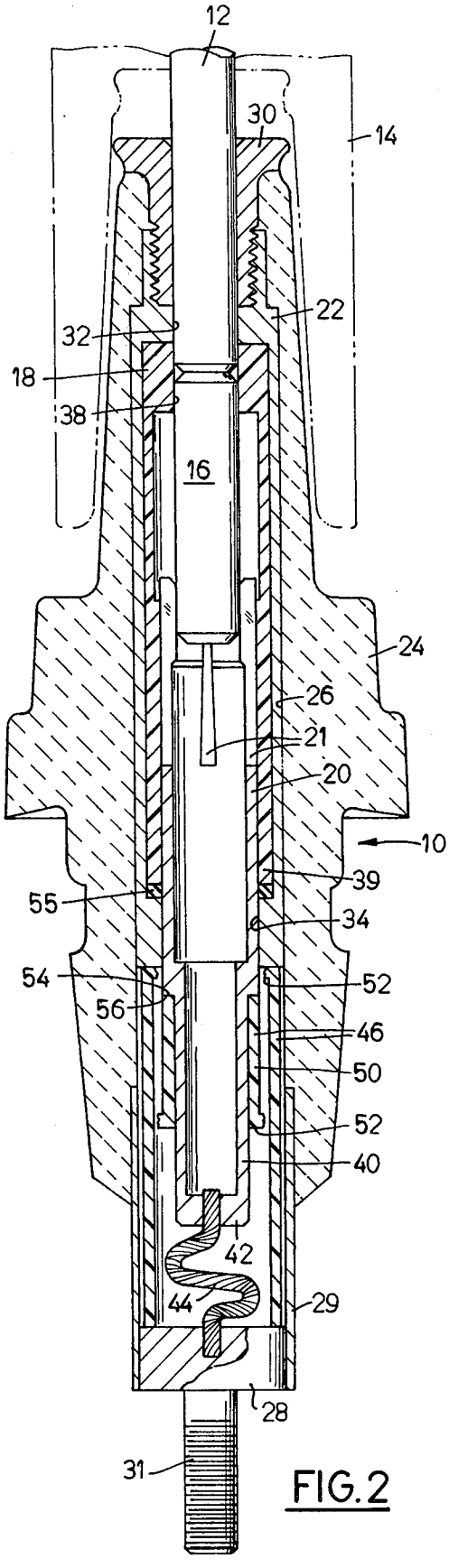

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FIG.2

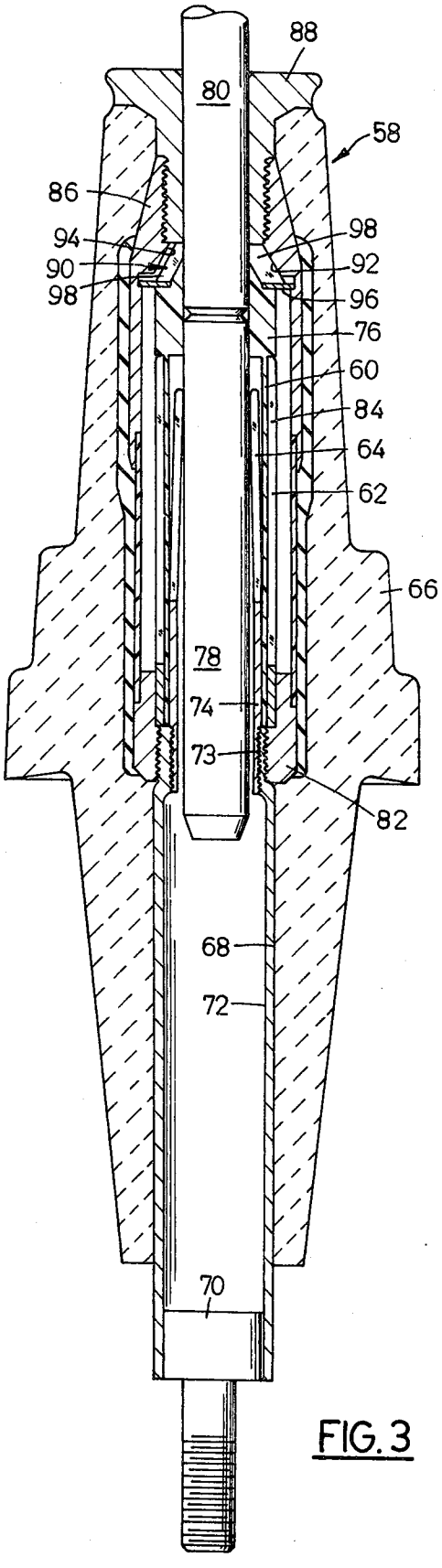

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FIG. 3

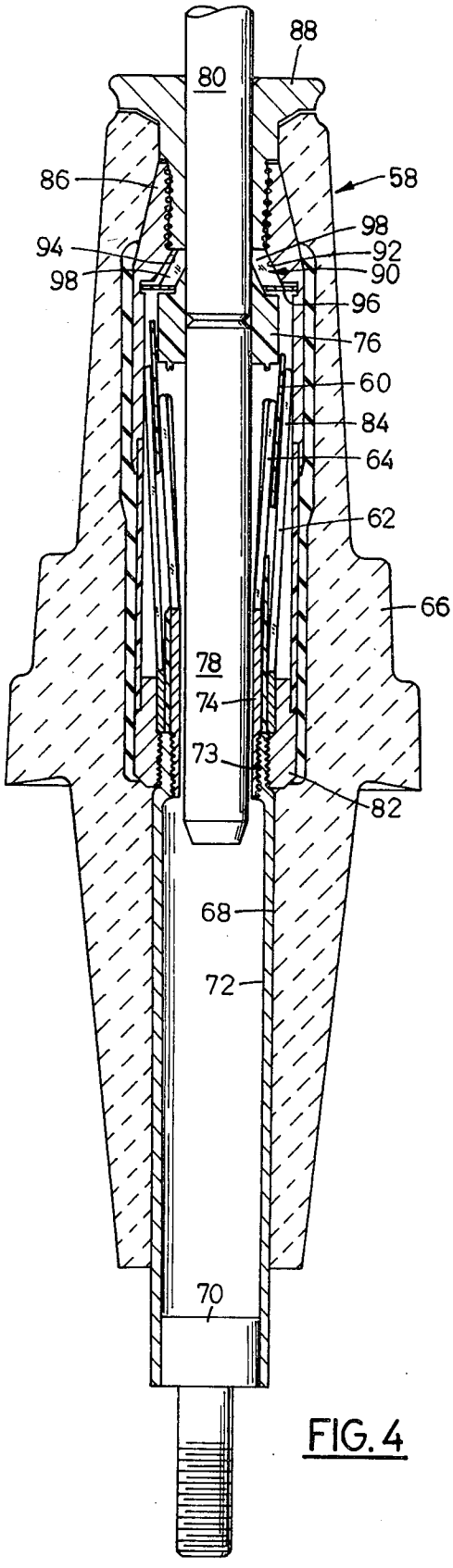

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FIG. 4

PRESSURE ACTUATED ELECTRICAL BYPASS CIRCUIT FOR A HIGH VOLTAGE BUSHING

Background of the Invention

In high voltage underground power distribution systems electrical termination is achieved by the manual movement of electrical contacts into engagement. When the open contacts are moved toward engagement with one another, an arc will form between the contacts before they actually come into engagement due to the high voltage breaking down the insulation air between the contacts. When the contacts are located in a confined space, a substantial danger exists that equipment may be excessively damaged or an operator may be injured as a result of the pressure of the gases developed in the interval between contact prestrike and electrical engagement of the contacts. This danger is heightened when gas evolving arc quenching materials are located adjacent the movable contacts. Under normal operating conditions, manual operation of the movable contacts in a power distribution system is generally satisfactory because the arc is not severe. However, an inherent danger in such systems is that a short circuit may be present on the system at the time of close-in. Under short circuit conditions, an abnormally high arc current would be created during the prestrike interval and prior to the electrical engagement of the contacts and this arc would usually develop enough gas to either throw one of the contacts toward the operator, or cause an explosion of the contact assembly.

Summary of the Invention

The present invention relates to a bushing for connecting an electrical apparatus to the conductive probe of a high voltage terminator. The bushing is provided with a frangible member to confine the gases developed during contact prestrike within the bushing so that the force of the gas can be used to complete an electrical bypass circuit between the bushing and terminator. In one embodiment, when the force of the gas pressure acting on the bushing contact exceeds the strength of the frangible member, the frangible member will break allowing the contact to move rapidly inwardly into the bushing into electrical engagement with the bypass circuit and thereby immediately extinguish the arc between the probe and the contact. In another embodiment, when the force of the gas pressure exceeds the strength of the frangible member, the frangible member will rupture forcing a conductive member into engagement with a conductive cylinder to complete the bypass circuit.

Drawings

FIG. 1 is a side view in section showing the bushing of this invention with the conductive probe shown at the entrance to the bushing and spaced from the element;

FIG. 2 is a view similar to FIG. 1 showing the position of the element after the frangible disc has been broken by the pressure of the gas developed on prestrike;

FIG. 3 is a view of another embodiment of the invention with the conductive probe at the entrance to the bushing; and

FIG. 4 is a view similar to FIG. 3 showing the frangible element after rupture and closing of the bypass circuit.

Description of the Invention

The bushing **10** of the present invention is used to connect the conductive probe or contact **12** of a terminator **14** to an electrical apparatus. A high voltage electrical connector assembly of this type is shown in U.S. Pat. No. 3,474,386 of Edwin A. Link entitled "Electrical Connector," issued on Oct. 21, 1969. In this type of a connector assembly, a gas evolving arc-quenching extension or rod **16** is provided on the end of the probe **12** and a gas evolving arc-quenching sleeve **18** is provided on the end of the conductive sleeve or contact **20** within the bushing **10.** The arc quenching material can be any of the well known arc extinguishing materials such as hard vulcanized fiber, the acrylics and polytetrafluoroethylene. The prestrike arc produced on close-in of the terminator **14** with the bushing will produce an arc-quenching gas between the extension **16** and sleeve **18** which will extinguish the arc under normal operating conditions. However, under short circuit conditions the pressure of the arc-quenching gas produced can create an explosive condition within the bushing **10.**

The bushing **10** of this invention is provided with an electrical bypass arrangement that is gas actuated to rapidly connect the sleeve **20** to the probe **12** whenever the gas pressure exceeds a predetermined limit determined by a frangible member within the bushing **10.** More particularly, the bushing **10** includes a housing **24** formed or molded from a dielectric material and having an axially extending passage **26.** The passage **26** is closed at one end by means of an electrically conductive cap **28** mounted on a supporting sleeve **29.** The cap **28** is provided with a threaded section **31** for connecting the bushing to an electrical apparatus. An arc-quenching gas evolving sleeve **30** is provided at the open end of the passage **26.**

Means are provided in the bushing **10** for rapidly connecting the probe **12** to the sleeve **20** in the form of an electrically conductive cylindrical bypass member **22** provided within the passage **26** on the inner end of the sleeve **30.** The member **22** includes a reduced diameter opening **32** at the inlet end for engaging the probe **12** and an opening **34** at the other end for electrically engaging the element **20.**

The sleeve or element **20** includes a number of slots **21** around the open end and a reduced diameter cylindrical section **40** at the inner end which extends through the opening **34** in the bypass member **22.** The cylindrical section **40** is closed by means of an end wall **42** and is connected to the cap **28** by means of a flexible electrically conductive wire **44.** It should be noted that the sleeve **20** is free to slide axially within the tube **18** from an operating position as seen in FIG. **1** to the electrical bypass position shown in FIG. **2.**

In this regard, the sleeve or element **20** is supported for sliding movement within the bypass element by means of the insulating tube **18** which is positioned with the bypass member **22.** The tube **18** includes a reduced diameter opening **38** at the inlet end for engaging the extension **16** and an enlarged diameter section **39** around the open end of sleeve **20.** The tube in the normal position of the sleeve or element **20** insulates the sleeve **20** from the bypass member **22.**

The sleeve **20** is retained in the operating position by means of a frangible insulator **46** provided at the inner end of the passage **26** in the bushing housing **24.** The

frangible insulator **46** includes a cylindrical section **48** which is positioned within the passage **26** and a cylindrical section **50** connected to the cylindrical section **48** by means of a frangible section or ring **52.** The cylindrical section **50** has an inside diameter substantially equal to the outside diameter of the cylindrical section **40** on the sleeve **20.** The section **40** is inserted into the reduced diameter section **50** until the end **54** of the section **50** abuts the shoulder **56** between the sleeve **20** and the cylindrical section **40.** It should be noted that the cylindrical section **50** electrically insulates the cylindrical section **40** from the opening **34** at the inner end of the bypass member **22** and seals the space between the section **48** in insulator **46** from the space in tube **18.**

The space between the outside surface of the section **50** and the inside surface of the insulator **18** should be sealed in order to prevent arching between the shoulder **56** of the sleeve **20** and the opening **34.** This can be accomplished by means of a seal ring **55** provided between the bypass member **22** and section **50** and also located between the inside end of tube **18** and the opening **34.**

Under normal operating conditions the prestrike arc created on close-in will be extinguished by the gas produced by the heat of the arc between the extension **16** and the sleeve **18.** When a fault condition is present on close-in, the heat of the prestrike arc will produce an increased gas pressure of a sufficient magnitude to exceed the strength of the frangible disc **52.** Since the gas is confined in the space within the sleeve **20** and insulating tube **18,** the sleeve **20** will act like a piston bearing on the frangible disc **52** until the disc **52** breaks allowing the sleeve **20** to move rapidly into the space in the cylindrical section **48** and away from the probe **12.**

The sleeve **20** will move far enough to electrically engage the opening **34** in the bypass member **22** setting up a bypass circuit through the member **22** to the probe **12.** The arc between the probe **12** and the sleeve **20** will be immediately extinguished due to the new current path through the electrical bypass member **22.** The arc length is now reduced because the gap between the probe **12** and the opening **32** in the bypass element **22** and between the opening **34** in the bypass element and the sleeve **20** is smaller than the original gap between the probe **12** and the sleeve **20.** This reduced arc length results in an immediate reduction in arc energy thereby preventing build up of gas pressure in the bushing.

FIGS. 3 and 4

In the embodiment of the invention shown in FIGS. **3** and **4,** the gases produced by the arc quenching materials are confined within a frangible cylinder **60** which on rupture allows the pressure of the gases to close an electric bypass circuit through an electrical bypass element **62** between the bushing **58** and probe **80** in the terminator. More particularly, the bushing **58** includes a housing **66** formed or molded from a dielectric material and having an axially extending passage **68.** The passage **68** is closed at one end by means of an electrically conductive cap **70** mounted in a tubular element **72** which includes a threaded section **73** at the inner end to threadedly receive the electrical contact **74.** The frangible cylinder **60** is mounted on and closely surrounds the contact **74.** The cylinder **60** is formed as an integral part of the arc quenching or snuffing cylinder **76** which has a reduced diameter to engage the arc extinguishing follower **78** and the electrically conductive probe **80** on the terminator.

Means are provided in the bushing **58** for rapidly connecting the probe **80** to the contact **74,** in the event of a fault. Such means is in the form of an electrically conductive element or sleeve **62** which is electrically connected at its inner end to the conductive tube **72** by means of a conductive support **82.** The element **62** includes a plurality of fingers **84** which are insulated from the contact **64** by the frangible cylinder **60.**

The element **62** is spaced from a conductive cylinder **86** which is mounted within the passage **68** of the bushing and supports an arc snuffer **88** located at the open end of the passage **68** in the housing **66.** The arc snuffer **88** has an internal diameter substantially equal to the outside diameter of the follower **78** and probe **80.**

Means are provided for clamping the probe **80** within the bushing to prevent blow back of the terminator in the event of a fault on close-in. Such means is in the form of a conductive clamp assembly **90** which is mounted on the end of the arc snuffer **76** in a position to engage the probe **80.** In this regard, the clamp **90** includes a number of elements having a radially outwardly tapered outer surface **92** positioned to ride on the inwardly tapered surface **94** on the conductive cylinder **86.** The clamp members are retained in the bushing by means of a seal ring **96.**

As seen in FIG. **4,** when an arc occurs as a result of a fault current, a build up of pressure will occur within the frangible cylinder **60.** When this pressure exceeds the strength of the cylinder, the cylinder will be sheared from the arc snuffer **76** and will be forced against the fingers **84** of the conductive element **62.** The fingers **84** will be blown outwardly into engagement with the conductive cylinder **86** forming an electrically conductive bypass circuit through the clamp assembly **90,** conductive cylinder **86,** the fingers **84,** the support member **82** and the conductive cylinder **72.**

If the force of the gas within the conductive cylinder **86** is of sufficient force to shear the arc snuffer **88** from the threaded connection with the conductive cylinder **86,** the clamp **90** will be moved into tight gripping engagement with the probe **80.** In this regard, as the pressure builds up on the seal **96,** the elements of the clamp **90** will be forced against the end of the arc snuffer **88.** When this force exceeds the shear strength of the threaded section of the arc snuffer **88,** the cylinder **86** will be moved axially outwardly from the bushing **58** allowing the clamp members **98** to be cammed inwardly on the tapered cam surface **94** on the conductive cylinder **86.**

I claim:

1. A bushing for connecting electrical apparatus to the conductive member of a high voltage cable terminator, said bushing including: a dielectric housing having a passage, an electrically conductive contact positioned within said passage, said contact being adapted to electrically engage the conductive member in the terminator, a frangible member within said passage, means for connecting said contact to the electrical apparatus, and electrical bypass means within said bushing for connecting said contact to the conductive member when the pressure of the gas produced by the heat of the prestrike arc on close-in is sufficient to break the frangible member.

2. The bushing according to claim **1** wherein said electrical bypass means comprises a cylindrical tube

positioned with said passage and having a section at one end for electrically engaging the terminator and a section at the other end for electrically engaging said contact.

3. The bushing according to claim **2** including an insulating sleeve positioned with said cylindrical tube for supporting said contact for axial movement within said passage.

4. The bushing according to claim **3** including a cylindrical section of insulating material mounted on said contact and being connected to said frangible member to confine the gases produced on prestrike to the inlet end of said passage.

5. The bushing according to claim **1** wherein said electrical bypass means includes a cylindrical section to provide electrical communication with the terminator and a sleeve mounted on said frangible member and extending into said cylindrical section whereby on rupture of said frangible member said sleeve will be forced into engagement with said section.

6. The bushing according to claim **5** including means within said cylindrical section for clamping the terminator in said bushing on rupture of said frangible member.

7. The bushing according to claim **6** wherein said clamping means responds to the pressure of the gases produced on fault close in.

8. The bushing according to claim **1** wherein said frangible member supports said contact within said passage.

9. The bushing according to claim **8** wherein said contact is movable into engagement with said bypass means on rupture of said frangible member.

10. A voltage bushing for connecting electrical apparatus to the conductive probe of a high voltage cable terminator, said bushing including: a dielectric housing, an electrically conductive tubular contact positioned within said housing, said contact being open at one end to electrically engage the conductive probe in the terminator on close-in, a gas evolving arc-quenching tube surrounding said contact and extending beyond the open end of said contact, a frangible member within said housing, said frangible member confining the gases produced by the prestrike arc on close-in within said contact, means within said housing for electrically connecting said contact to the electrical apparatus, and electrically conductive bypass means within said bushing for electrically connecting the electrical apparatus to the conductive probe when the pressure of the gas within the contact is sufficient to rupture the frangible member and allow electrical engagement of said electrically conductive bypass means with said probe.

11. The bushing according to claim **10** wherein said electrical bypass means comprises a hollow tubular member positioned within said bushing and having a section at one end for electrically engaging the probe and a section at the other end for electrically engaging said contact.

12. The bushing according to claim **10** wherein said frangible member includes a cylindrical section mounted on said contact and extending partially into said gas evolving tube.

13. The bushing according to claim **11** wherein said frangible member includes a cylindrical section surrounding one end of said contact extending through the section at the other end of the electrical bypass means and partially into the arc-quenching gas evolving tube.

14. The bushing according to claim **13** including means positioned between the cylindrical section and the arc-quenching tube for sealing the contact from the reduced diameter section of the electrical bypass means.

15. The bushing according to claim **10** wherein said electrical bypass means includes a cylindrical section to provide electrical communication with the probe and a sleeve surrounding said frangible member and extending into said cylindrical section whereby on rupture of said frangible member, said sleeve will be forced outwardly into engagement with said cylindrical section.

16. The bushing according to claim **10** wherein said bypass means includes a clamp assembly positioned to respond to the increase of pressure within said bushing on rupture of said frangible member to clamp the probe in the bushing.

17. The bushing according to claim **10** wherein said frangible member is integral with and forms an extension of the said arc-quenching tube.

18. The bushing according to claim **15** including an arc-quenching sleeve secured to said cylindrical section at the open end of the passage in said bushing and a clamp assembly mounted within said cylindrical section and bearing against said arc-quenching sleeve, said assembly being positioned to respond to the pressure of the gas within the bushing on rupture of said frangible member to break said sleeve and move into clamping position with respect to said probe.

* * * * *