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 pre-strike 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.
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 cylinder 32, the 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 the 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 on 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 upper 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.

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
3,884,542

5

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.

* * * * *