

[54] ELECTRICAL DISCONNECT

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339/143 C

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339/91, 143, 177

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[57]

ABSTRACT

A high-voltage, electrical disconnect including an axially elongated terminal adapted to make and break contact with a fixed contact upon axial movement relative thereto. An annular elastomeric insulating filler is provided around said terminal and is formed with an open-ended recess in coaxial alignment with said terminal for receiving an insulating member around said fixed contact. Radial compression means is provided around said insulating filler for establishing void-free, interfacial contact between said insulating member and the surface of the recess in the elastomeric insulating filler when said terminal and the fixed contact are connected together.

8 Claims, 7 Drawing Figures

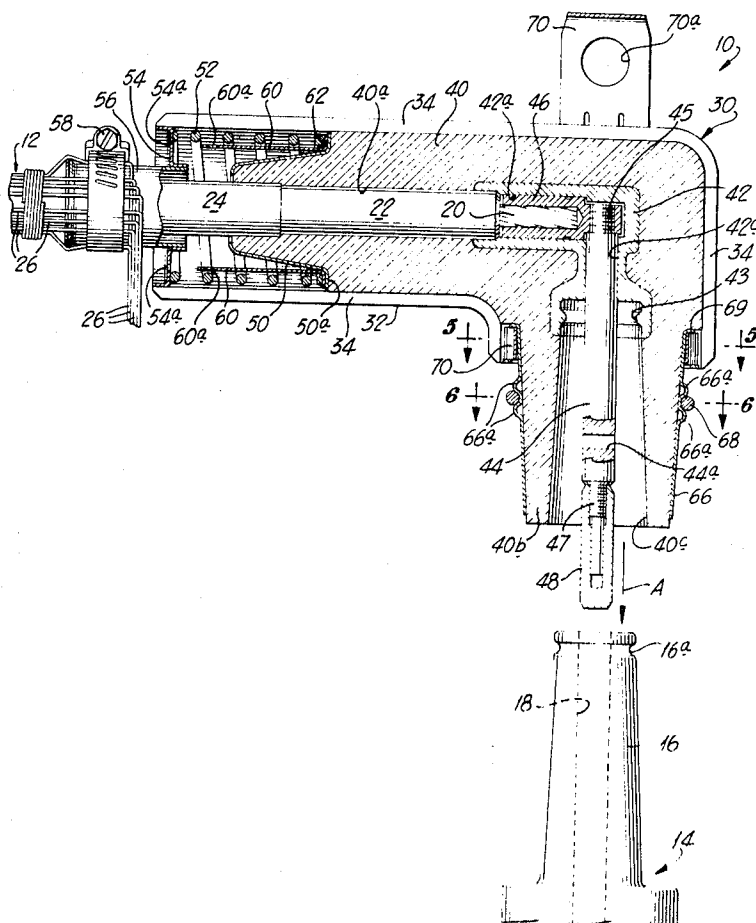
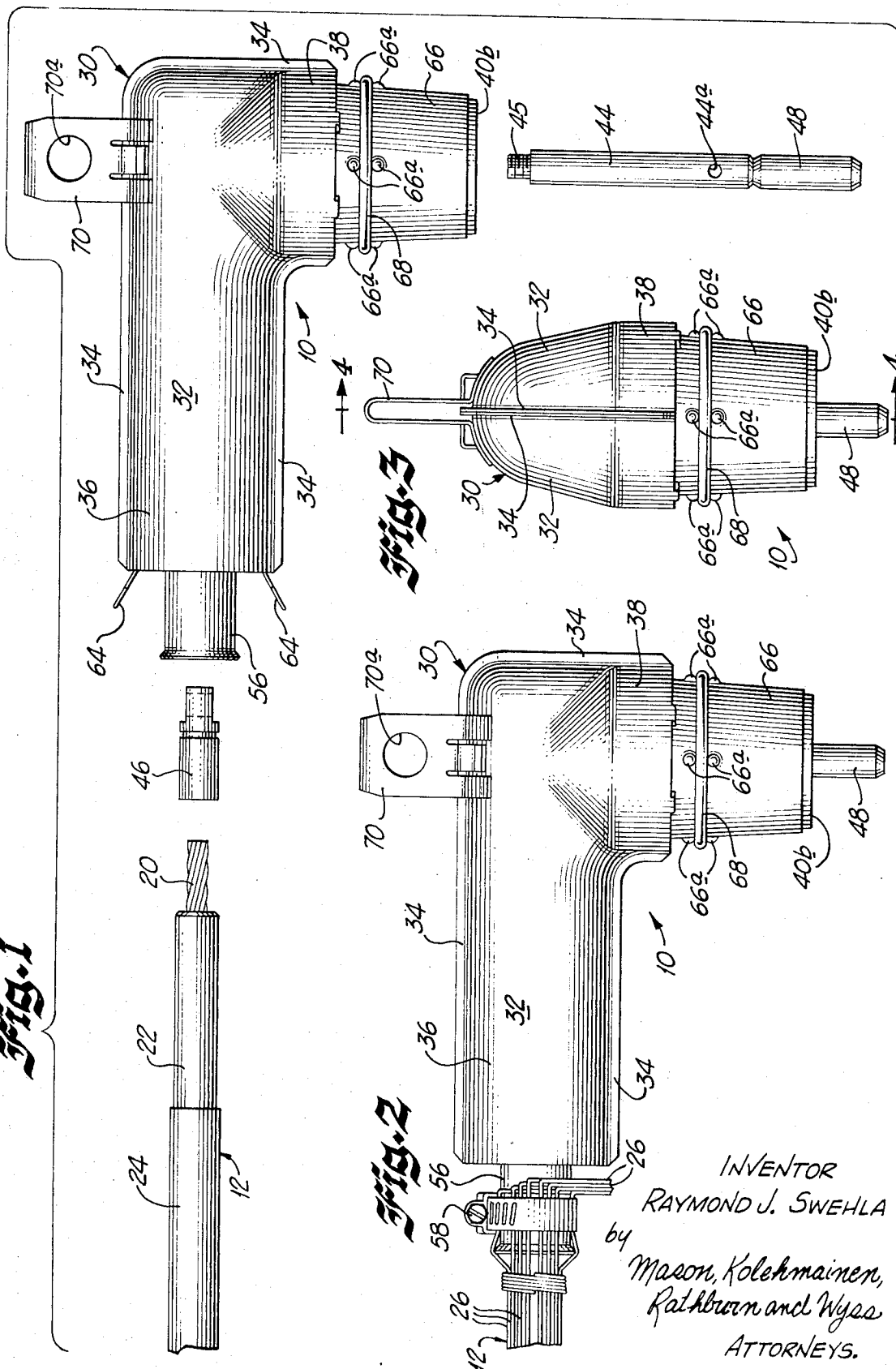


Fig. 1



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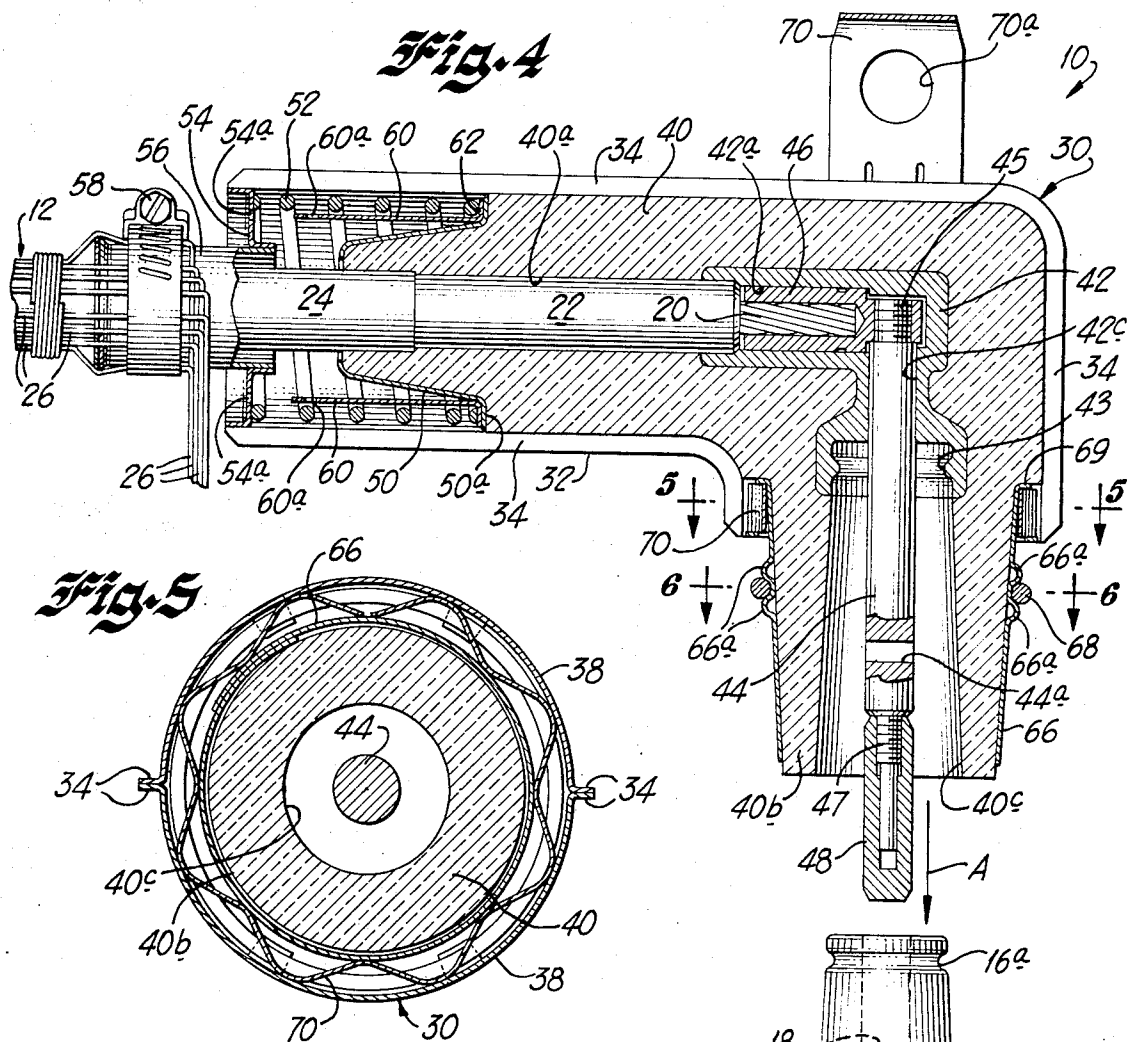


Fig. 5

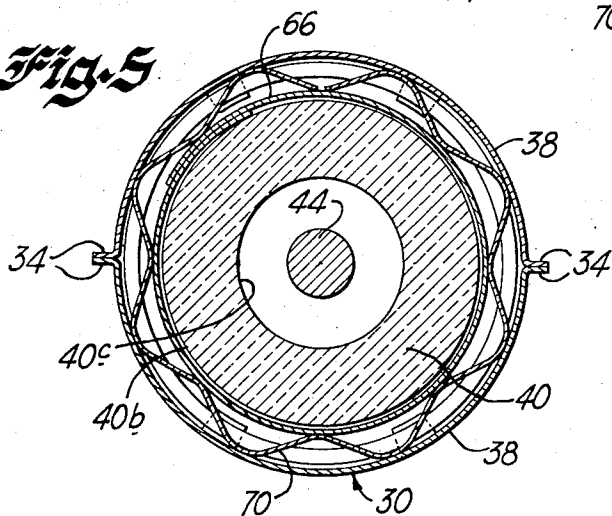


Fig. 6

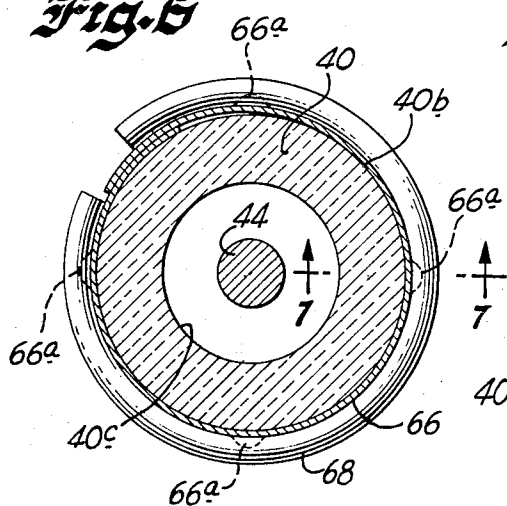
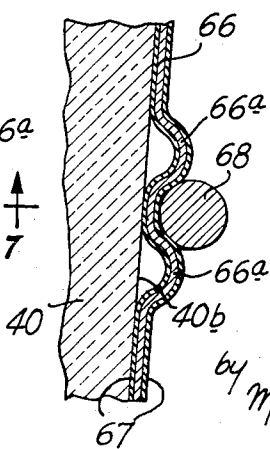
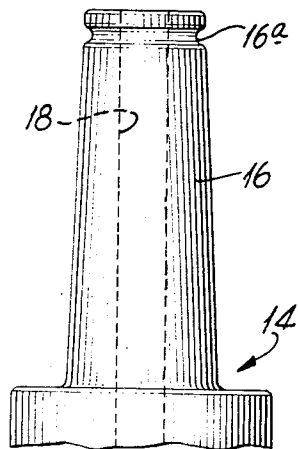


Fig. 7



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ELECTRICAL DISCONNECT

The present invention relates to a new and improved, high-voltage, electrical disconnect and, more particularly, to a high-voltage, electrical disconnect which is suitable for use in underground distribution systems wherein a grounded protective outer shell is provided around central coaxial power cable.

The disconnect of the present invention is an improvement over the grounded surface distribution apparatus shown and described in the copending U.S. Pat. application, Ser. No. 4,396, filed Jan. 20, 1970, said application being a continuation of U.S. Pat. application Ser. No. 660,748, filed Aug. 15, 1967, and now abandoned.

The disconnect of the present invention is especially well suited for coaxial, high-voltage, power cables commonly used in underground power distribution systems. These cables include an axial center conductor which is covered by an extruded insulating jacket and a conductive, protective outer shield is provided around the insulating jacket. The disconnect of the present invention is adapted to terminate a power cable of the aforementioned type and to make and break contact with a fixed terminal contact. The disconnect can be worked hot or cold and can be connected and disconnected while under load, using a hot stick.

It is therefore an object of the present invention to provide a new and improved, high-voltage, electrical disconnect suitable for use with coaxial power distribution cables, and the like.

Another object of the present invention is to provide a new and improved, high-voltage disconnect of the character described for terminating coaxial power cables and adapted for connecting and disconnecting the circuit while under load.

Another object of the present invention is to provide a new and improved high-voltage, electrical disconnect of the character described which provides uniform symmetrical stress gradient in the insulating dielectric material around the conductors adjacent the connection so that corona discharge and radio noise are eliminated.

Another object of the present invention is to provide a new and improved, high-voltage, electrical disconnect of the character described including new and improved means for maintaining a void-free, interfacial, surface contact between movable and fixed dielectric insulating members in the disconnect and fixed terminal, respectively, while connected together.

Another object of the present invention is to provide a new and improved, high-voltage, electrical disconnect of the character described wherein an elastomeric insulating filler is compressed radially inwardly around a fixed insulating member in a manner providing a substantially void-free, interfacial, surface contact between the two insulators.

The foregoing and other objects and advantages of the present invention are accomplished in an illustrated embodiment comprising a high-voltage, elbow-type, electrical disconnect including an axially elongated, center power terminal adapted to make and break contact with a cooperating fixed contact member upon axial movement relative thereto. An annular elastomeric insulating filler surrounds the power terminal and is formed with an open-ended recess in coaxial alignment

with the terminal for receiving the insulating member around the fixed contact member of the cooperating fixed terminal assembly. Radial compression means is provided around the annular elastomeric insulating filler for establishing void-free interfacial contact between the elastomeric filler and the insulating member of the fixed terminal assembly when the disconnect is in a connected position.

For a better understanding of the present invention, reference should be had to the following detailed description taken in conjunction with the drawings, in which:

FIG. 1 is an exploded side elevational view of a high-voltage, electrical disconnect constructed in accordance with the features of the present invention and showing a terminal end portion of a coaxial-type power distribution cable with which the disconnect is used;

FIG. 2 is a side elevational view of the disconnect shown as it is after installation and connection with the coaxial power cable;

FIG. 3 is a front elevational view of the disconnect looking in a direction toward the power cable connected therewith;

FIG. 4 is a longitudinal, sectional view of the high-voltage disconnect showing the internal components thereof and a cooperating fixed terminal assembly associated therewith;

FIG. 5 is a transverse, cross-sectional view taken substantially along line 5—5 of FIG. 4;

FIG. 6 is a transverse, cross-sectional view taken substantially along line 6—6 of FIG. 4; and

FIG. 7 is an enlarged, fragmentary, sectional view taken substantially along line 7—7 of FIG. 6.

Referring now, more particularly, to the drawings, therein is illustrated a new and improved, grounded, surface distribution apparatus comprising a load-break, elbow-type disconnect constructed in accordance with the features of the present invention and indicated generally by the reference numeral 10. The load-break disconnect elbow 10 is adapted to be used with a high-voltage, coaxial-type, power cable 12 (commonly used for underground power distribution systems) for connecting and disconnecting with a fixed terminal assembly 14 (FIG. 4), which includes an upstanding, frustoconical, rigid insulator 16 having an elongated axial socket 18 defined therein for receiving a center terminal of the disconnect. The high-voltage power distribution cable 12 includes a center conductor 20 made up of a plurality of separate strands, and the center conductor is surrounded by an extruded, plastic, insulating jacket 22. The insulating jacket 22 is covered with a semiconducting insulating shield 24 and a plurality of neutral wires 26 are provided around the semiconductive insulating jacket.

In accordance with the present invention, the load-break elbow disconnect 10 includes a stainless steel, protective housing, generally indicated by the reference numeral 30 and formed in two cooperating half sections 32 which are assembled and secured together along edge flanges 34 (preferably in a continuous steam-welding process). The housing 30 is formed with a long leg 36 adapted to receive a terminal end portion of the coaxial power cable 12 and a relatively short leg 38 at right angles thereto. The interior of the elbow housing 30 is filled with a high dielectric

urethane insulating elastomer filler generally indicated by the reference numeral 40. The filler 40 is preferably cast in place within the stainless steel housing 30 in a vacuum casting project, so that all air voids are eliminated between the housing and the filler. The longer leg of the filler 40 is formed with an elongated axial bore 40a adapted to receive the specially prepared terminal end portion of the coaxial power cable 12 (as shown in FIG. 1). The elastomeric filler 40 is formed with a downwardly and outwardly projecting frustoconical skirt portion 40b having an axis at right angles to the elongated bore 40a (FIG. 4) and which extends outwardly beyond the short leg portion 38 of the housing. The skirt portion 40b of the filler is formed with an inwardly extending, tapered, frustoconical recess 40c in coaxial alignment with the central axis of the leg 38. The socket or recess 40c is adapted to receive the upwardly projecting insulator 16 of the fixed terminal assembly 14 when connection is made with the elbow disconnecter 10 on the fixed terminal assembly.

In accordance with the present invention, at the junction or intersection of the longitudinal axes of the bore 40a and the recess 40c with the filler 40, there is provided an elbow 42 formed of semiconductive elastomeric material, indicated generally by the reference numeral 42 and cast or embedded directly in the filler. The semiconducting, elastomeric elbow 42 provides for electrical contact between an elongated terminal pin 44 which is coaxially centered and projects downwardly from the frustoconical recess 40c and the center conductor 20 of the power cable 12. For this purpose, the semiconductive elbow 42 is provided with a bore 42a in coaxial alignment with the cable receiving bore 40a, and at right angles thereto a terminal pin receiving bore 42c which is in coaxial alignment with the frustoconical recess 40c in the filler. The lower end portion of the bore 42c is enlarged to form a continuation or extension of the main socket or recess 40c formed in the filler 40. The enlarged lower end of the bore 42c formed with an inwardly extending, deflectable, annular, locking ridge 43, which is adapted to seat within an annular recess 16a formed adjacent the upper end of the insulator 16 of the fixed terminal assembly 14, when connection is made between the disconnecter 10 and the fixed terminal assembly.

The bore 42a of the semiconducting contact elbow 42 is adapted to receive a connector 46 which is of the compression fitting type and which is compressed onto the exposed end portion of the center conductor 20 in the power cable 12. When the power cable 12 is prepared for connection, portions of the insulating jacket 22 and outer shield 24 are stripped back, as shown in FIG. 1, and the compression fitting 46 is inserted onto the exposed length of the center conductor 20 and compressed by a tool to make a low resistance, high current capacity contact therewith. The prepared, stripped back, end portion of the power cable 12 with the compression fitting 46 in place thereon is then inserted into the elongated bore 40a of the elastomeric filler 40 until the fitting is fully seated home against the end of the bore 42a of the semiconducting elbow 42.

As best shown in FIG. 4, the outer end of the compression fitting 46 is formed with a threaded bore at right angles to the longitudinal axis thereof, and the

threaded bore is adapted to receive a threaded upper end 45 of the main terminal pin 44, as best shown in FIG. 4. The lower end of the terminal 44 includes a downwardly projecting, threaded, end portion 47 which is adapted to extend into the axial bore of a replaceable, terminal pin tip portion 48. The threaded upper end 45 of the terminal pin 44 (as best shown in FIG. 1), is passed upwardly through the bore 42c of the semiconducting elbow 42, and the terminal pin is rotated about its longitudinal axis until the thread end is tightened fully in the cross bore at the end of the compression fitting 46. Rotation of the terminal pin 44 is accomplished by a Z-shaped wrench (not shown) having a short leg which is insertable into a transverse recess 44a formed in the lower end portion of the terminal pin.

As shown in FIG. 4, the cable jacket 22 extends into the outer end of the bore 42a of the semiconducting elastomeric elbow 42 when the cable is fully inserted, and the longer leg of the dielectric elastomeric filler 40 is provided with a frustoconically tapered outer end face to engage a thrust member 50. The thrust member 50 includes an annular outer radial flange portion 50a for exerting axial end pressure on the filler and the frustoconical center portion of the thrust member compresses the filler inwardly against the inserted cable. After insertion of the prepared cable end portion into the axial bore 40a of the filler 40, a restrained compression spring 52 is released to exert inward end pressure on the filler. The spring is mounted in the housing 30 between the flange of the thrust member 50a and an outer end wall 54 is of circular shape, which is flange welded or otherwise secured to the inside surface of the housing 30 adjacent the outer end of the longer leg 36. The end wall 54 is formed with a flanged center opening and a cable guide bushing 56 of conductive metal is welded thereto. The guide bushing 56 includes a radially outwardly tapered outer end portion for guiding the cable 12 into the bore 40a of the elastomeric filler 40 and for preventing chafing or wear on the outer surface of the cable because of angular misalignment between the cable and the axis of the elbow leg 36. The guide bushing also serves as a grounding connection for the neutral wires 26 of cable which are secured to the bushing by a stainless steel compression ring 58. The end wall 54 is formed with a pair of openings 54a and restraining legs 60 connected to an annular spring retainer 62 extend through the openings to maintain the spring 52 in compressed condition until released. Each restraining leg 60 is provided with a slot 60a adjacent its outer end, and a removable key 64 is inserted in the slot to bear against the outer surface of the end wall 54 to maintain the spring 52 in a compressed condition prior to assembly and insertion of the power cable 12.

A detailed description and discussion of the operation and release of the compression spring 52 to exert axial compression on the filler around the cable end portion is not included herein, and reference should be had to U.S. Pat. No. 3,532,803, issued on Oct. 6, 1970, which patent is incorporated herein by reference. When the pull keys 64 are removed from the slots 60a of the restraining legs 60, the spring 52 is released and the annular ring 62 forces the thrust member 50 against the outer end portion of the filler 40. This process

eliminates air between the interfacial surfaces of the portion of the cable shield 24, jacket 22, and the surface of the bore 40a in the filler.

The neutral wires 26 are in contact with the semiconducting ground shield 24 of the power cable 12 and are positively secured to the guide bushing 56 which in turn is electrically and physically connected to the housing elbow 30 through the end wall 54, thus completing the grounding circuit.

In accordance with the present invention, the depending frustoconical skirt 40b of the filler 40 is squeezed radially inwardly against the insulator 16 of the fixed terminal assembly 14 when connection is made in order to establish substantially air-free, interfacial contact between the frustoconical surface of the recess 40c and the matching outer surface of the insulator 16. For this purpose, a radial compression assembly is provided including a frustoconical outer shell 66 and a split or C-ring type spring 68. The frustoconical shell 66 is formed of conducting material, such as metal, and forms a protective, grounded shield for the filler skirt 40b. The shell is split longitudinally in order that it may be compressed radially inwardly to squeeze the filler skirt portion 40b against the surface of the insulator 16 on the fixed terminal assembly 14. The shell is formed with a radial annular flange 69 at the upper end, which is seated within the short leg 38 of the elbow housing 30 and bears against an annular surface on the filler around the depending skirt portion 40b. Grounding connection between the upper end of the frustoconical shell 66 and the housing is provided by means of a star-shaped ring 70, best shown in FIG. 5, having a plurality of outer apexes which bear against the inside surface of the grounded housing 30 in the leg portion 38. The ring 70 includes a plurality of inner apexes which bear against the upper end portion of the shell 66. The shell is formed with a coating 67 of dielectric insulating material, such as hard porcelain, and the like (best shown in FIG. 7), but the upper end of the shell 66 within the housing 30 is not covered with the insulating porcelain in order that electrical contact is well established between the star ring 70 and the housing wall.

The C-ring type compression spring 68 is held in position intermediate the ends of the contractable shell 66 by means of a plurality of radially spaced pairs of longitudinally spaced projections 66a formed on the outside surface of the shell. As best shown in FIG. 7, the spring 68 is seated between the spaced pairs of projections 66a and is free to compress the longitudinally split, frustoconical shell 66 radially inwardly to force the filler skirt 40b against the surface of the insulating member 16 of the fixed terminal assembly 14.

In making or breaking connection between the disconnect 10 and the fixed terminal assembly 14, the terminal pin 44 is axially aligned with the socket 18 (as shown in FIG. 4), and is moved axially downward in the direction of the arrow "A" until fully seated. When fully seated, the insulator 16 of the terminal assembly 14 is fully inserted in the frustoconical recess 40c of the filler skirt 40b. The disconnect 10 is maintained in the connected condition by the ridge 43 in the socket or recess 42c of the semiconducting elbow 42, which is engaged in the groove 16a at the upper end of the insulator 16. In addition, locking pressure is supplied by the

C-ring spring 68 which exerts pressure radially inwardly on the filler skirt portion 40b of the filler against the insulator 16. This radially inwardly directed pressure or compression establishes a void-free, interfacial contact between the insulating members 16 and the surface of the recess 40c in the elastomeric filler and, at the same time, electrical contact is established between the lower end or replaceable low arcing tip 48 of the terminal pin 44 which is in contact with a female connector (not shown) within the socket 18 of the fixed terminal assembly 14.

The present invention provides a new and unique disconnect 10 which employs an elastomeric insulating filler 40 adapted to receive the terminal end portion of a power cable at one end and adapted to make contact with a fixed terminal assembly. The disconnect may be worked out by means of a hot stick and, for this purpose, a radial flange lug 70, having an access opening 70a therein, is welded or otherwise secured to the back of the disconnect housing 30 adjacent the elbow thereof. Radial squeezing is provided to insure void-free interfacial contact between the filler and a fixed terminal assembly, and axial pressure is provided to establish void-free interfacial contact between the filler and a power cable.

While there has been illustrated and described a single embodiment of the present invention, it will be appreciated that numerous changes and modifications will occur to those skilled in the art, and it is intended in the appended claims to cover all those changes and modifications which fall within the true spirit and scope of the present invention.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A high-voltage disconnect including an axially elongated center terminal adapted to make and break contact with a cooperating fixed terminal assembly upon axial movement relative thereto, an annular elastomeric insulating filler around said center terminal formed with an open-ended recess in coaxial alignment with said center terminal for receiving an insulating member of said cooperating terminal assembly, said open-ended recess being of a frustoconical shape having an enlarged outer end for receiving said fixed insulating member, and radial compression means around said insulating filler for establishing void-free, interfacial contact between said fixed insulating member and the surface of said recess in said elastomeric filler when said center terminal and said cooperating terminal assembly are axially thrust together into contact, said radial compression means including a conductive, radially contractable, annular, ground shell around said annular elastomeric insulator, and ring means around said shell biasing the same to contract radially inwardly toward said annular, elastomeric, insulating filler, said ground shell being frustoconical in shape and tapered in a direction opposite that of said recess, said shell being split longitudinally to permit radial contraction.

2. The high-voltage disconnect of claim 1 wherein said ring means comprises a C-ring spaced intermediate opposite ends of said shell, and spaced-apart projections on said shell for retaining said spring against movement longitudinally thereof toward the smaller end.

3. A high-voltage disconnect including an axially elongated center terminal adapted to make and break contact with a cooperating fixed terminal assembly upon axial movement relative thereto, an annular elastomeric insulating filler around said center terminal formed with an open-ended recess in coaxial alignment with said center terminal for receiving an insulating member of said cooperating terminal assembly, said open-ended recess being of a frustoconical shape having an enlarged outer end for receiving said fixed insulating member, and radial compression means around said insulating filler for establishing void-free, interfacial contact between said fixed insulating member and the surface of said recess in said elastomeric filler when said center terminal and said cooperating terminal assembly are axially thrust together into contact, said radial compression means including a conductive, radially contractable, annular, ground shell around said annular elastomeric insulating filler, ring means around said shell biasing the same to contract radially inwardly toward said annular, elastomeric, insulating filler, grounding shell means around a portion of said elastomeric insulating filler away from said open-ended recess, and ring means electrically connecting said grounding shell means and an annular portion of said conductive shell.

4. A high-voltage disconnect comprising in combination male and female center terminals movable axially between connected and disconnected positions, an annular, elastomeric, insulating filler around one of said terminals including an open-ended socket at one end; a rigid, annular, insulating member around the other of said terminals adapted to seat within said socket in void-free, interfacial contact with said elastomeric in-

5. The disconnect of claim 4 wherein said semiconducting contact and said rigid insulating member include detent means for maintaining engagement therebetween upon axial connection of said male and female terminals.

6. The disconnect of claim 5 wherein said filler is formed with an elongated cable receiving recess in communication with said semiconducting contact.

7. The disconnect of claim 6 including connector means for interconnecting said contact with a power cable inserted into said cable-receiving recess.

8. A high-voltage cable termination including a cable guide for concentric neutral cable, said cable guide being formed of an inner end portion attached to said termination, a central portion comprising a hollow sleeve having an outwardly flared outer end flange for guiding said cable into said termination and having an outer surface for contacting the concentric neutrals of said cable when said cable is inserted in said sleeve, and clamping means for securing the concentric neutrals around said sleeve inwardly of said outwardly flared outer end flange for preventing detachment of said neutrals from said central portion.

9. The cable termination of claim 8 including a cable guide for concentric neutral cable, said cable guide being formed of an inner end portion attached to said termination, a central portion comprising a hollow sleeve having an outwardly flared outer end flange for guiding said cable into said termination and having an outer surface for contacting the concentric neutrals of said cable when said cable is inserted in said sleeve, and clamping means for securing the concentric neutrals around said sleeve inwardly of said outwardly flared outer end flange for preventing detachment of said neutrals from said central portion.

10. The cable termination of claim 9 including a cable guide for concentric neutral cable, said cable guide being formed of an inner end portion attached to said termination, a central portion comprising a hollow sleeve having an outwardly flared outer end flange for guiding said cable into said termination and having an outer surface for contacting the concentric neutrals of said cable when said cable is inserted in said sleeve, and clamping means for securing the concentric neutrals around said sleeve inwardly of said outwardly flared outer end flange for preventing detachment of said neutrals from said central portion.

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