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HIGH-VOLTAGE ELECTRICAL CONNECTOR

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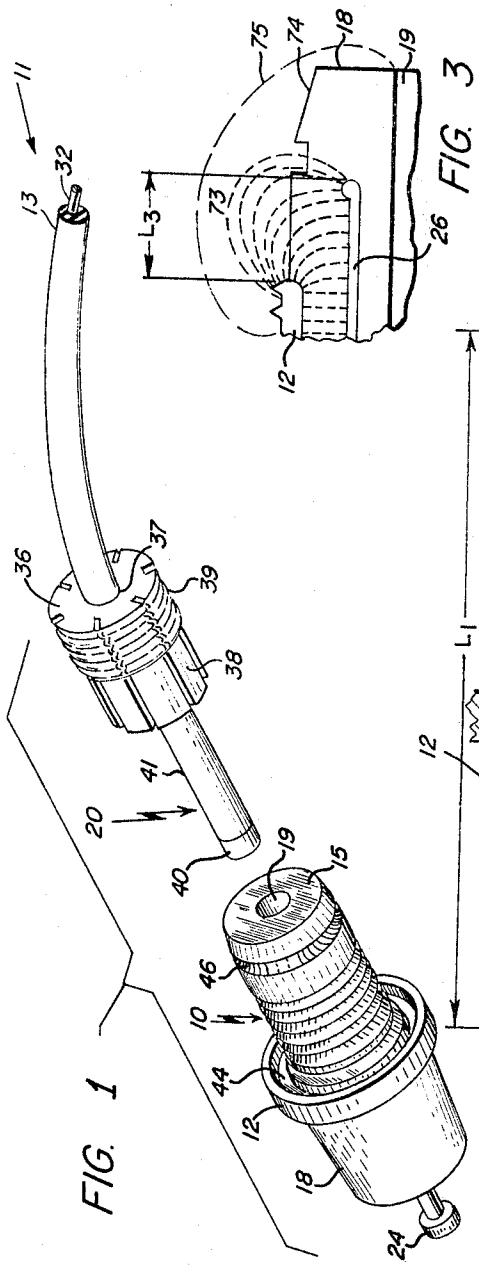


FIG. 1

FIG. 3

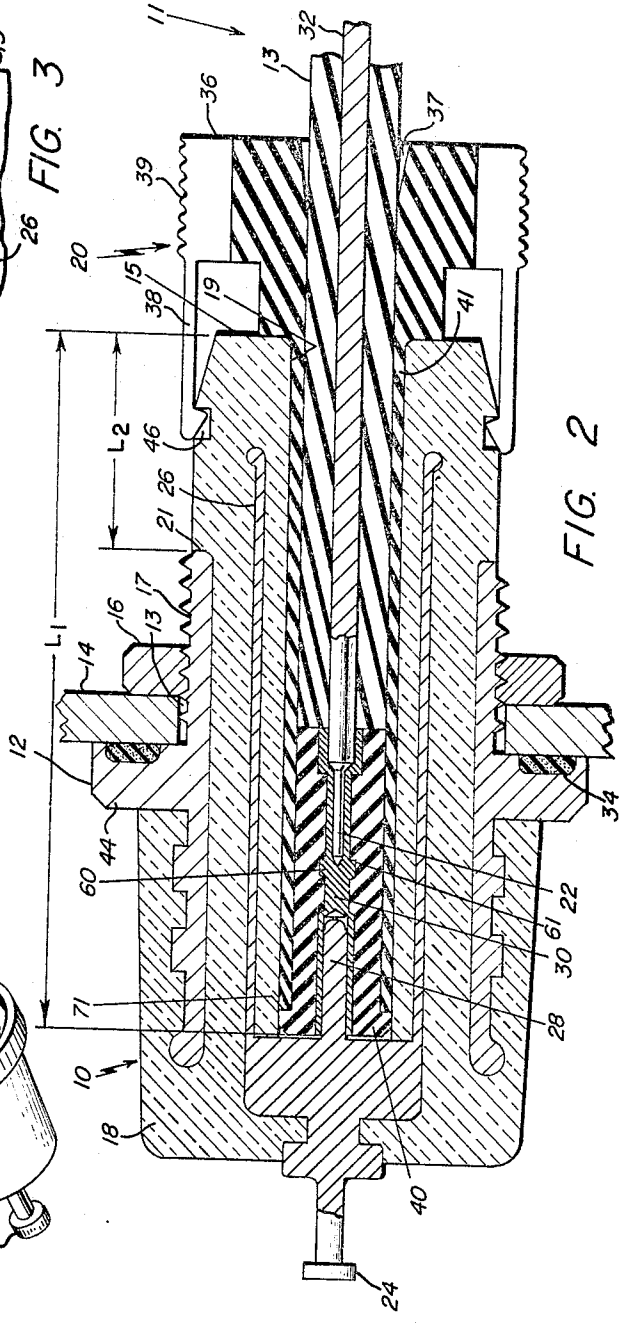


FIG. 2

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HIGH-VOLTAGE ELECTRICAL CONNECTOR

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This invention relates to high-voltage connectors and more particularly to a high-voltage connector for coupling high-voltage wires through the walls of electrical apparatus.

It is often desirable to provide readily removable high-voltage connections to the interior of electrical apparatus. In the past, such connections have usually been made by providing an insulating bushing of generally rod-shaped appearance having a central conductor member running lengthwise through the bushing. The bushing extends through a hole provided in the external wall or metallic chassis of the electrical apparatus and the high-voltage lead is connected to the external end of the central conductor, as by soldering or bolting the high-voltage wire to the central conductor member. The bushing is normally secured to the wall of the electrical apparatus by providing a metallic flange portion on the bushing member, said flange portion being secured to the wall about the periphery of the hole provided in said wall. The remaining end of the bushing central conductor extending into the interior of the electrical apparatus is coupled in a similar manner to the appropriate terminal of the electrical apparatus.

In such prior-art devices the walls of the electrical apparatus are normally at ground or very low potential. Accordingly, a breakdown path for the high voltage is available from the external central conductor member directly to the wall of the electrical apparatus. By increasing the length of the bushing the breakdown path can be increased, but it is often desirable to have the bushing as short as possible so that the electrical apparatus will fit into confined areas. The farther the bushing extends out of the electrical apparatus, the more susceptible it becomes to inadvertent breakage in shipping and installation. In order to increase the distance of such breakdown path without increasing the length of the bushing, prior-art connectors of this type have been provided with alternate horizontally extending flanges and grooves on the exterior of the bushing so as to increase the surface area of the insulating bushing body and thereby increase the voltage breakdown or creepage path from the external connection to the wall of the electrical apparatus. Dirt and moisture are frequently trapped in these grooves, thus providing a lower dielectric path and impairment of the insulating quality of the bushing. Also, the number of grooves is limited by the diameter and length of the external portion of the bushing.

In the apparatus of the present invention a much lower breakdown path for the same length of insulator is provided by a novel connector means comprising insulating means having a longitudinal opening therein to accommodate an insulated high-voltage cable; a first stress-distributing member concentric about said opening and having a terminal portion at one end of said longitudinal opening, which portion extends externally of said insulating means, and a second stress-distributing member concentric about said first stress-distributing member. A flange portion is provided on said second stress-distributing member and the connector means of the invention is inserted through the hole in the wall of the electrical apparatus until the flange portion abuts the periphery of said hole. A fastener secures the connector in this position. The high-voltage insulated cable is inserted into the longitudinal opening in the insulator means and electrical connection between the inner conductor of the high-voltage cable and the terminal portion of said first stress-distributing member is made at the terminal end of said longitudinal opening. Accordingly, it will be seen that in the apparatus of the invention, the breakdown path for high voltage comprises the distance extending from the terminal portion of the stress-distributing member along the length of the longitudinal opening plus the usual distance from the start of said opening to the lower-potential wall of the electrical apparatus.

The apparatus of the invention as thus described in addition to increasing the voltage-breakdown path without the necessity for lengthening the size of the insulator means also prevents the formation of corona in the insulated high-voltage cable. The formation of corona is prevented by connecting the center conductor of the high-voltage cable to the terminal portion of the first stress-distributing member. The first stress-distributing member forms a shield concentric about the high-voltage insulated cable so that essentially all of the electrostatic stresses occur between the first and second stress-distributing members which are insulated from one another by said insulator means which is preferably comprised of a high dielectric strength medium such as ceramic or the like of uniform dielectric constant and is accordingly better able to prevent the formation of corona than the flexible insulator of a high-voltage cable. Other objects and advantages of this invention will become apparent from the following specification taken in connection with the accompaniny drawings in which:

FIG. 1 is a perspective view of the plug member and jack member of the preferred embodiment of the invention shown before connection;

FIG. 2 is a cross-sectional view of the plug and jack members of FIG. 1 in the mated position; and

FIG. 3 is a view of a portion of the apparatus of FIG. 2 showing the high-voltage stress lines.

In FIG. 1 there is shown a connector of the invention comprising a jack member **10** and a plug member **20**. Jack member **10** can be seen to comprise in general an outer stress-distributing member **12** concentric about a ceramic or other insulative body **18**. Outer stress-distributing member **12** is preferably comprised of a conductive material such as brass, aluminum or the like and is provided with a flanged portion **44** for purposes subsequently to be described. Insulative body **18** is provided with an opening **19** extending longitudinally into the interior of said insulative body so as to provide a receptacle for plug member **20**. Plug member **20** is comprised of three main portions, a hollow tubular portion **41**, a socket portion **36** and springable fingers **38**. Plug member **20** is preferably formed from an insulative material of semi-rigid properties such as nylon, Teflon or the like. High-voltage conductor **11** having an outer insulative portion **13** and an inner conductor portion **32** is inserted through opening **37** in plug member **20** and electrical connection is made between internal conductor **32** and a conductive adapter socket provided in insert **40** of tubular portion **41** in a manner subsequently described in detail in connection with FIG. 2. The plug member **20** is then inserted in the opening **19** in jack member **10** and pressed downward into the jack member until springable fingers **38** on plug member **20** make contact with the groove **46** formed in the insulative body **18** of jack member **10**. When the plug member **20** is in this position, electrical contact will be established between terminal portion **24** of jack member **10** and internal conductor **32** of wire cable **11** as will now be shown in detail in connection with FIG. 2.

Referring specifically to FIG. 2, there is shown a cross-section of a preferred embodiment of the connector apparatus of the invention in which the plug member **20** and jack member **10** have been mated as previously described and wherein the jack member is shown mounted in place on a panel member **14** of electrical apparatus (not shown). Jack member **10** is affixed to wall **14** by inserting the jack **10** through opening **13** provided in wall **14** and threading nut **16** over threaded portion **17** provided on outer stress-distributing member **12** until O-ring **34** is sufficiently compressed against flange portion **44** of outer stress-distributing member **12**, thereby to provide a hermetic seal about the periphery of hole **13**. It should be noted that the direction of mounting plug member **10** on panel **14** may be reversed by interchanging the positions of the flange portion **44** and threaded portion **17** so that the threaded portion would be on the left side of panel **14** and the flange portion on the right side of panel **14** as viewed in FIG. 2.

In accordance with the preferred embodiment of the invention, the internal conductor **32** of high voltage cable **11** is connected to terminal portion **24** of inner stress-distributing member **26** at the end of longitudinal opening **19** in jack member **10** so as to increase the length of the high voltage breakdown path. Before discussing this connection it is first necessary to consider the detailed construction of plug member **20**. As aforementioned, high-voltage cable **11** is inserted through opening **37** in tubular portion **41** of plug member **20**. The end of center conductor **32** which extends through tubular portion **41** is formed into the shape of a pin designated as pin **22**. Insert **40** has a conductive adapter portion **30** secured on pin portion **22** and fixedly secured in electrical contact thereto as by soldering, crimping or the like. Insert **40** is pressed over adapter portion **30** and secured thereto by extensions **60** and **61** in adapter portion **30** which extend into corresponding ridges in insert **40**. Insert **40** is then pressed into opening **37** from open end thereof. The outer diameter of insert **40** is slightly larger than the inner diameter of opening **37**; accordingly, a forced fit is secured between the two members and a rigid structure is formed including the insert portion **40** and the wall **41** of plug member **20**. The plug member as thus assembled is then inserted into opening **19** of jack member **10** until contact is made between fingers **38** and groove **46**. When such contact is established, the end of adapter **30** opposite pin **22** makes contact with jack pin **28** which in turn is in electrical contact with terminal portion **24** of inner stress-distributing member **26**. There is thus formed a complete electrical path for high voltage from inner conductor **32** to pin portion **22**, to adapter **30**, to jack pin **28**, and ultimately to terminal portion **24**. It is noted at this point that this connection can be readily broken, without the necessity for unsoldering or unbolting, by merely grasping the knurled portion **39** of plug **20** and exerting a sufficient force to the right as shown in FIG. **2** to enable spring fingers **38** to slip out of groove **46** in which case the connection between jack pin **28** and adapter **30** will be broken and plug member **20** may be readily removed from the longitudinal opening **19** in jack member **10**.

In accordance with the invention, an inner stress-distributing member **26** is provided concentric with the longitudinal opening **19** in insulative body **18**. Said inner stress-distributing member is comprised of a conductive material such as copper, brass, aluminum or the like and is preferably formed as an integral portion of terminal member **24** and jack pin **28** as shown in FIG. 2. Inner stress-distributing member **26** serves to distribute the high voltage present on lead **32** between the outer stress-distributing member **12** and the inner stress-distributing member **26**. The two aforesaid stress-distributing members are insulated from one another

by insulative body **18** which is preferably of a very high dielectric strength material, such as ceramic, Teflon, epoxy resins, silicone resins or the like. The insulative body **18** is better able to withstand the high electrical stresses caused by the high potential difference between the outer and inner stress-distributing members than the high-voltage cable **12** because of the absence of unequal dielectric constant materials in the medium between the two stress-distributing members. Accordingly, the apparatus of the invention effectively eliminates the formation of corona, and resultant breakdown of insulative material is thereby prevented.

It is further noted that the apparatus of the invention as thus far described provides a greater voltage breakdown path through air for a given connector length than is presently provided in the known prior-art connectors. In the present invention the only breakdown path for high voltage through air is from jack pin **28** along the length of the longitudinal opening **19** in insulative body **18**, a length designated L_1 in FIG. 2 and thence from surface **15** of insulative body **18** to surface **21** of outer concentric stress distributing member **12** a distance designated L_2 in FIG. 2. In the prior-art devices wherein connection was made at the external portion of the insulative bushing, the breakdown path for high voltage was at most equal to the distance L_2 plus any small additional distance provided by the knurled configuration of the bushing body. It thus becomes apparent that the apparatus of the invention provides a compact high-voltage connector having a relatively long voltage-breakdown path and inner and outer corona-preventive shields, which connector may be readily connected and disconnected without the necessity for soldering or bolting apparatus.

A further feature of this invention is illustrated in FIG. 3 which is a view of a portion of the connector apparatus of FIG. 2 and shows schematically the high-voltage stress lines present between inner and outer concentric stress members **26** and **12** respectively. As shown in FIG. 3, upon connection of a high-voltage lead to terminal portion **24** of jack member **10**, a plurality of stress lines **73** are created between inner concentric stress member **26** and outer concentric stress member **12**. By making the length of inner stress member **26** longer than outer stress member **12** so that the inner stress member projects a distance L_3 past the outer stress member the stress lines **73** form a curved trajectory as shown in FIG. 3, said trajectory extending external of insulating member **18**. The fact that these stress lines extend external of the insulated member **18** prevents high-voltage breakdown from taking a path along the external surface **74** of insulative member **18** because the high-voltage breakdown path cannot run through or across the stress lines **73**. Accordingly, the path must be as shown along the dotted line designated **75**. This feature of the invention thereby effectively increases the length of the high-voltage breakdown path since the breakdown path **74** on the external surface of insulative member **18** is much shorter than a corresponding path through air because of the unavoidable buildup of moisture and dust particles and consequent decrease of dielectric strength on surface **74**.

This completes the description of the connector apparatus of the present invention. However, many modifications of the invention will be apparent to persons skilled in the art. Also, other methods and devices may be chosen for securing the connector to the panel such as pinning, brazing, soldering, or the like. Accordingly, it is desired that this invention not be limited except as defined by the appended claims.

What is claimed is:

1. A jack member adapted to retain a plug member, said plug member comprised of a hollow tubular insulative portion having a socket portion at one end and

having resilient fingers extending from said socket portion about said tubular portion, said jack member comprising:

a tubular insulator body having a longitudinal opening therein to accommodate a high-voltage insulated wire having an inner conductor and an outer insulative portion, said insulator body having an undercut groove extending about the circumference thereof providing a depression for the fingers of said plug member;

a first metallic cylinder extending about said longitudinal opening and having a terminal portion closing one end of said opening, said terminal portion extending externally from said tubular insulator body;

and a second metallic cylinder extending about said first metallic cylinder and having a flange extending outward from said tubular insulator body.

2. Apparatus for coupling high voltage from one location to another comprising:

cable means having an outer insulative sheath and an inner conductive wire;

a plug member comprised of a semi-rigid insulative material forming a hollow tubular portion, a socket portion at one end of said tubular portion and springable fingers extending from said socket portion and concentric about said tubular portion;

insert means extending into said hollow tubular portion and having a conductive adapter socket secured to the inner conductive wire of said cable means;

and a jack member comprising an outer stress distributing member, an inner stress distributing member, insulation means intermediate said stress distributing members and forming a receptacle within said inner stress distributing members to retain the tubular portion of said plug member, and conductor means coextensive with the termination of said opening coupled to one end of said inner stress distributing member, said plug member being inserted

in said jack member so that electrical contact is established between the end of said inner stress distributing member coupled to said conductor means and the conductive adapter socket of said insert means.

3. Apparatus for coupling high voltage from one location to another comprising:

cable means having an outer insulative sheath and an inner conductive wire;

a plug member comprised of a semi-rigid insulative material forming a hollow tubular portion, a socket portion at one end of said tubular portion and resilient fingers extending from said socket portion and overlying said tubular portion;

insert means extending into said hollow tubular portion and having a conductive adapter socket secured to the inner conductive wire of said cable means;

and a jack member comprising insulator means having a longitudinal opening therein to accommodate the tubular portion of said plug member, a first stress distributing member concentric about said opening and having a terminal portion at one end of said longitudinal opening and extending externally of said insulator means, and a second stress distributing member concentric about said first stress distributing member.

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