# United States Patent [19]

**Schurter et al.**

[11] **3,813,639**

[45] **May 28, 1974**


[54] **ELECTRICAL CONNECTION FOR HIGH VOLTAGE ELECTRICAL SYSTEMS**


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[73] Assignee: **International Telephone and Telegraph Corporation**, New York, N.Y.



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[21] Appl. No.: **238,562**

[52] **U.S. Cl.** ..... **339/111**, 174/73

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

[58] **Field of Search** ..... 339/111, 143 R, 143 L, 339/143 S, 143 T, 95 R, 59 R, 59 L, 59 M, 60 R, 60 L, 60 M, 61 R, 61 C, 61 L, 61 M; 174/73



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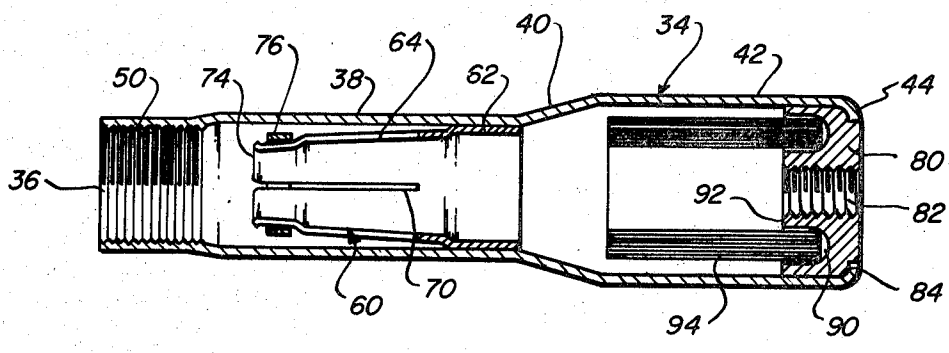
[57] **ABSTRACT**

Disclosed is a non-vented electrical connector designed to mate with a connection to a transformer or the like in a primary power distribution system. The connector will mate with and make electrical connection with a load break terminator as used in such systems, so that an electrical circuit carrying high currents at elevated voltage levels may be broken in the field without harm to the service personnel making and breaking the connection. The connector has internal members for suppressing the arc generated by high current, high voltage circuit openings and closures. In addition, the connector has internal structure for rapidly condensing and diffusing gases formed within the connector by an arc. In this way, the gas pressure developed in the connector is relieved to prevent pressure blowouts of the terminator. The gas condensing structure shown includes further, a multiple thickness tubular screen, which may be comprised of a length of fine mesh screen coiled into a tubular form. In addition, the connector has an internal scraping member which contacts the arc follower and removes surface contaminants to prevent such contaminants from adding to an arc and to prevent secondary arcing due to the presence of such contaminants in the path of an arc.


**16 Claims, 6 Drawing Figures**



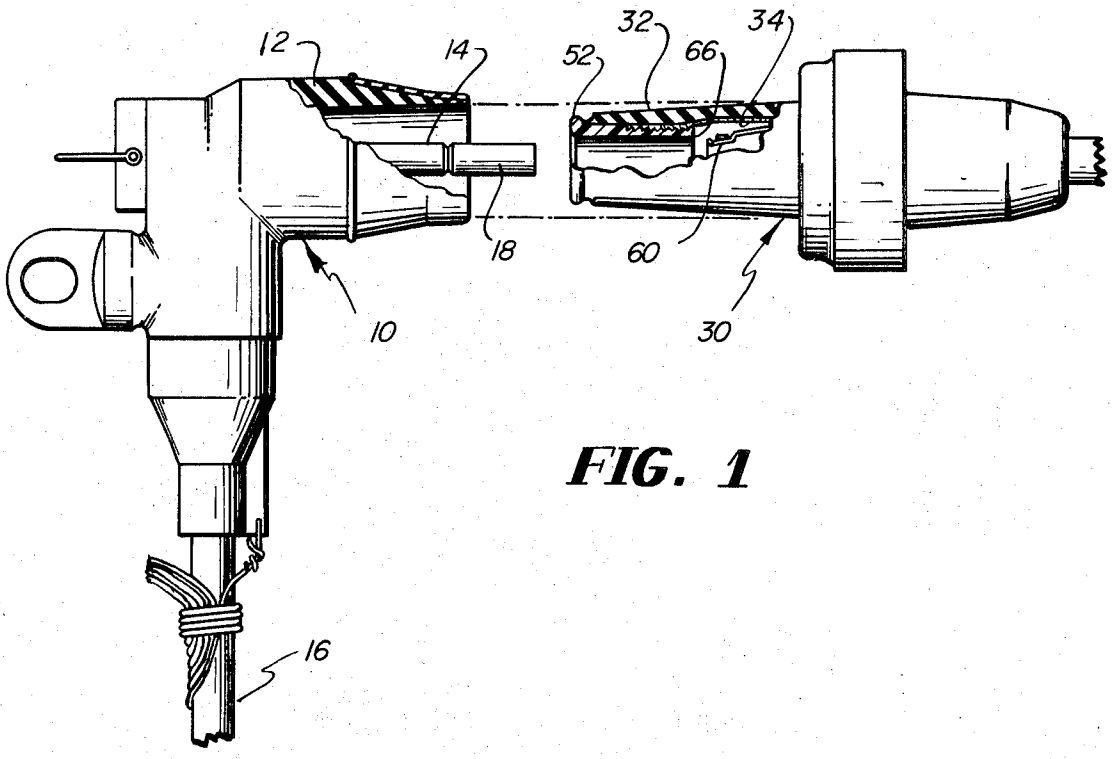



FIG. 1

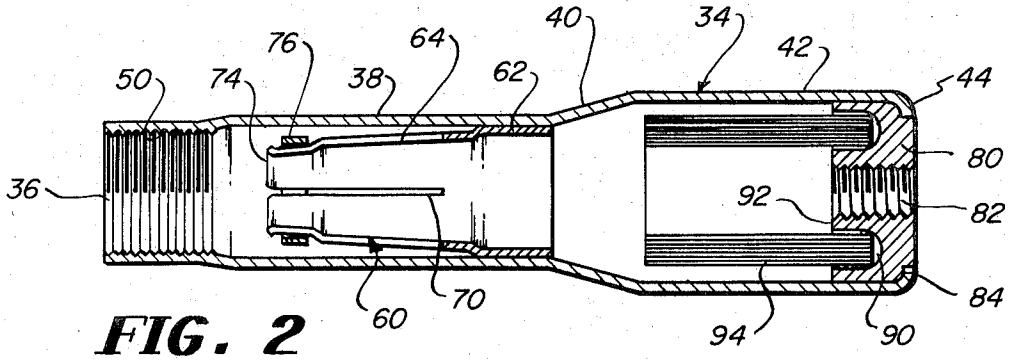



FIG. 2

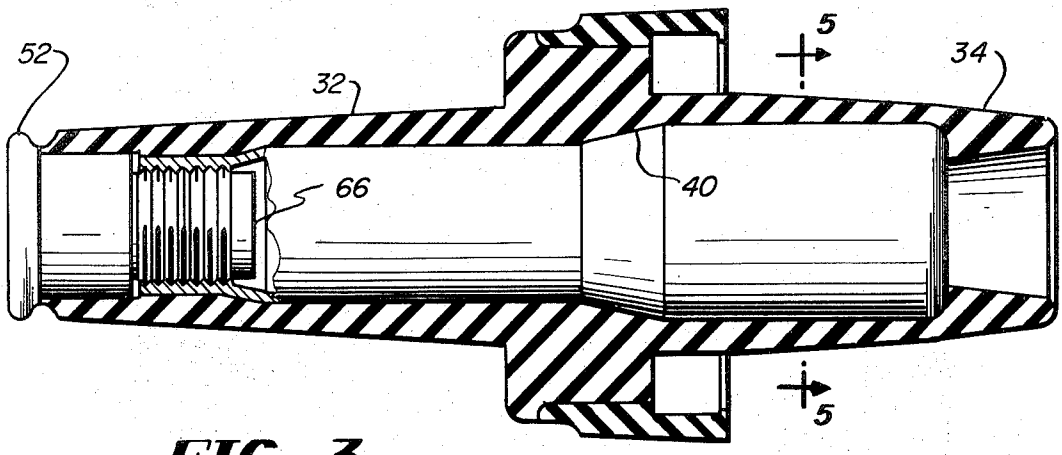



FIG. 3

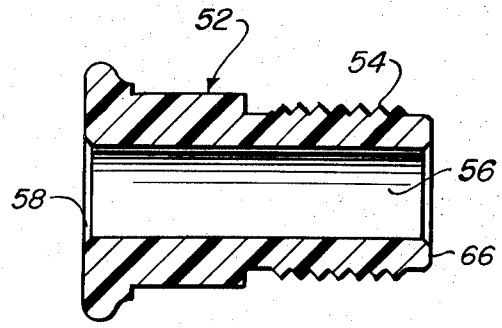



FIG. 4

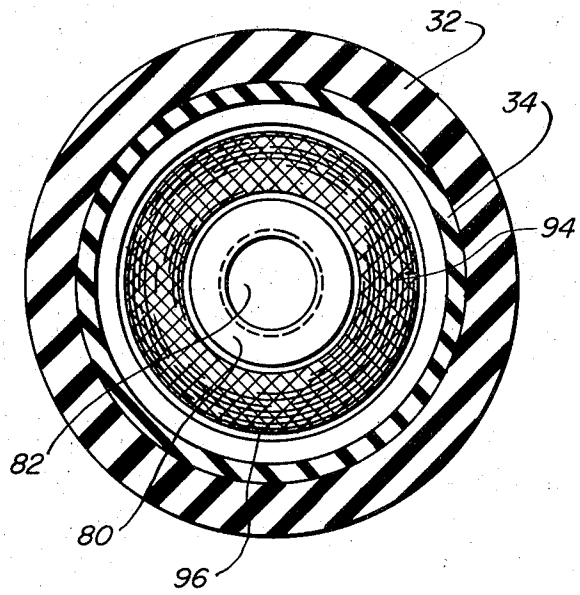



FIG. 5

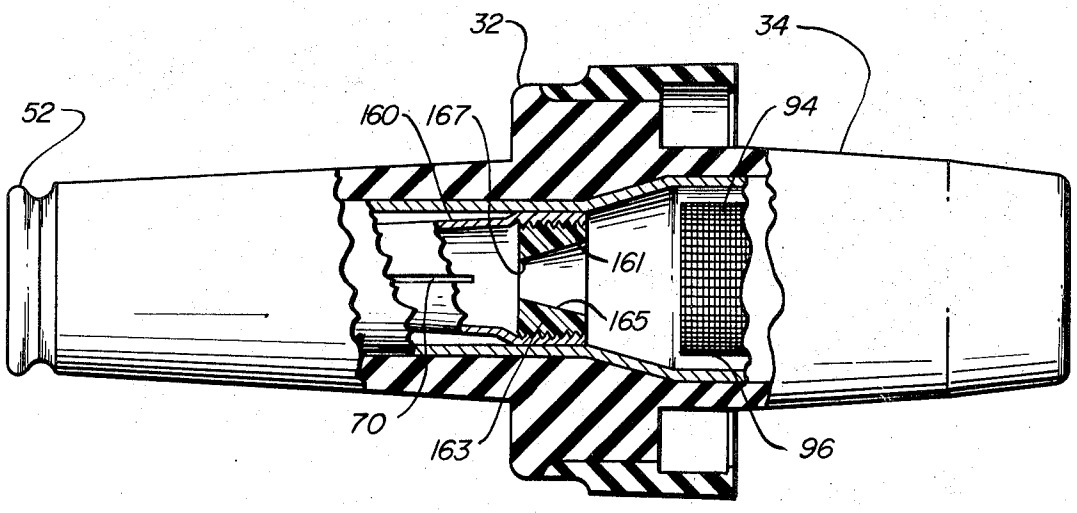



FIG. 6

# ELECTRICAL CONNECTION FOR HIGH VOLTAGE ELECTRICAL SYSTEMS

## BACKGROUND OF THE INVENTION

The present invention is designed to receive a load break terminator of the type disclosed in co-pending application Ser. No. 85,651, filed on Oct. 30, 1970, by R. A. Strain, for "Waterproof High Voltage Connection Apparatus" and assigned to the assignee hereof. In the application noted, there is shown an elbow terminator which, in one form, may be rated at standard 200 amp, 8.3 kv for connecting a shielded cable detachably in conjunction with a suitable plug to a power transformer or the like. For effecting the electrical contact with the connector the terminator has a central conductive electrode with an arc follower pilot rod at its exposed tip. The arc follower, as mentioned, has an elongated tip or rod of arc suppressing dielectric material.

Arc followers are designed to enter the axial cavity of a connector. The connector, as mentioned, may be electrically connected at its other end to a distribution transformer and thus must carry heavy current at elevated voltages from the transformer to the terminator. During entry of the terminator electrode into the connector cavity, first the suppressor and then the conductive body of the electrode will pass through a tube of arc suppressant or arc snuffing material until the conductive body of the electrode electrically contacts a female body member of conductive material.

The connection between the terminator and the connector is designed to be closed and opened under nominal power distribution voltages and currents, with the power on. With voltages and amperages of the magnitudes, as is known in the art, arcs are generated during the passage of the terminator electrode into and out of the connector. The arc suppressant materials are used to cut down the arc but they do not completely suppress the arc and, as a result, there may be a rapid internal pressure buildup in the connector cavity.

It is, of course, well known in the art that arc-generated pressure within a closed connector cavity, if unrelieved, can shove the elbow or terminator back out of the connector with a snap-action speed, opening the circuit, and possibly harming the person opening or closing the circuit.

To relieve such pressure within the connector cavity, some systems have used venting to the outside of the connector. In some cases, two compartments are formed within the connector cavity. The compartments are connected to one-way valves designed to blow out under heavy pressure and thus vent the pressure from the first compartment to the second compartment after dissipating some of the pressure.

Other systems have employed a flexible cable connected to a slidable female conductive structure. On the occurrence of arcing and its resultant internal pressure within the connector, the pressure tends to generate piston action forcing the female structure to advance rapidly toward the arc follower conductor. Rapid advance of the female structure will cause the follower-to-connector circuit to close rapidly, thus terminating the arc. The flexible cable maintains the closed circuit condition between the female structure to the transformer.



These solutions require moving parts such as valves and pistons and generate internal movements resulting from arc-induced pressure. Naturally, any system which tends to subject pistons and valves to elevated temperatures and pressures will tend to have a short life and may readily fail in service. Any system which does not rely on moving parts will be more capable of providing more foolproof action capable of continuous positive service, at reasonable cost.

## SUMMARY OF THE INVENTION

The present invention provides a non-vented, load-break connector for connection to a power distribution member such as a transformer by means of a stud connection or the like. The connector is capable of detachably receiving at its other end a load break terminator for connection to a primary line comprising a grounded shield cable.

The connector is designed to permit the terminator to be safely connected and disconnected from the bushing with nominal power distribution voltages and currents energized. Also, with nominal distribution fault current ready to flow through the connection at the start of connect, the connector may be damaged but the operator performing the connecting should not be harmed, provided the circuit is protected by adequate circuit protection devices.

The arc suppression features used herein include the use of an arc snuffer tube within the connector entry area for receiving the arc follower of the terminator electrode to aid in suppressing a generated arc. In addition, at the rear of the connector cavity, there is provided a coaxially disposed configured connector plug end opposing an arc-generated pressure wave. Within the plug end is fitted one end of a mesh screen multiple thickness tube. The tube opening is in communication with the cavity of the connector in which an arc would be formed so that produced gases enter the tube core. The mesh screen of the tube rapidly condenses the gases to relieve the pressure in the bushing cavity. The large surface area of the screen within the tube enables the screen to condense a large volume of gas in a short span of time and thereby dissipate the internal pressures within the connector.

In addition, there is provided intermediately within the connector, a scraper ring of arc suppressant dielectric material positioned to engage the wall of the arc follower and scrape contaminants from the follower during making or breaking of the circuit. By removing contaminants, the problems of secondary arcing and continuation of the main arc due to the pressure of contaminants is reduced to a minimum.

It is, therefore, an object of the invention to provide a new and improved connector for use with a load break terminator.

It is a further object of the invention to provide a connector within which a heavy power carrying circuit can be made and broken safely.

It is a further object of the invention to provide a load break connector with improved internal pressure relieving structure.

It is another object of the invention to provide a load break connector in whose internal cavity is mounted a gas condensing and cooling structure.

These and other objects, features and advantages of the invention will become apparent from the following

specification viewed in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a side elevational view of a load break terminator and receiving connector (both partially broken away to show the interior thereof) aligned with respect to one another and spaced from one another;

FIG. **2** is a sectional view through the connector internal body member of FIG. **1**;

FIG. **3** is a sectional view through the outer housing of the connector of FIG. **1**;

FIG. **4** is a sectional view through the arc snuffing member of FIG. **1**;

FIG. **5** is a sectional view taken along lines **5—5** of FIG. **3**; and

FIG. **6** is a side elevational view of a load break connector partially broken away to show the interior of a second embodiment of the invention.

## DETAILED DESCRIPTION OF THE DRAWINGS

Turning to the drawings, in FIG. **1**, we show a load break elbow terminator **10** of the type shown in copending U.S. Pat. application Ser. No. 85,651, filed Oct. 30, 1970 by R. A. Strain, and assigned to the assignee hereof. The load break terminator is of the type which is connected at one end to the conductor of a grounded sheathed cable **16.** The cable is connected to a conductive member or splice within the terminator dielectric and semiconductive housing (as described in the cited reference). The conductive member is, in turn, rigidly connected to a central conductive electrode **14** in rod form coaxially disposed within a hollow tubular open end of the housing **12.** The electrode **14** is recessed from the open end **18** of the housing and has connected to its outer end a dowel rod **20** of suitable arc suppressant dielectric material. The follower acts as a pilot or guide for the electrode and serves an arc suppressing function, as is well known in the art.

The connector **30,** one form of which is shown in FIGS. **1–3,** is designed to mate with the terminator **10.** The connector has an outer dielectric housing **32** which may be molded rubber. The housing incorporates a "molded-on" ground shield which will establish a ground plane about the exposed portion of the connector upon installation, and decreases the electrical stress field level in that area. The insulation of the housing may be pressure molded rubber and the ground shield may be of a semi-conductive elastomer. This housing has an entry end sized to mate with and fit snugly into the open end of terminator housing **12.** Fitted tightly within the connector housing **32** is an open-ended copper tube or body shell **34.** The open mouth end **36** of shell **34** is recessed from the entry opening of the housing to eliminate the risk of any inadvertant contact. The tube or shell extends in a plurality of progressively stepped or tapered sections **38, 40** and **42** of greater diameter to its open remote end **44,** as will be described later.

The entrance to the tube adjacent mouth end **36** is internally threaded at section **50** to receive a complementarily threaded tube-like arc snuffer **52,** shown in detail in FIG. **4.** The arc snuffer **52** may be fabricated of arc suppressant material like that of the arc follower rod of the terminator and is designed to remain in the connector until replaced. A suitable material for use in the arc snuffer is a material composed of polyoxymethylene with glass fiber or borosilicate filler. The arc snuffer is suitably externally threaded along its outer surface **54** to mate with the threaded copper tube at section **50.** The snuffer has central bore **56** sized to receive the terminator arc follower rod **20** and also the terminator electrode **14.** The outer end **58** of the snuffer bore is internally chamfered to receive and guide the follower rod **20,** and its periphery is flared at flange **59** to rest against the opening of the connector housing **32.**

Within copper tube **34,** as seen best in FIG. **2,** there is fitted a tubular female contacting member or receiving electrode **60** fabricated of copper or the like, which has a rear body portion **62** fitted tightly and suitably crimped within the adjacent body section **38** of tube **34.** The receiving electrode **60** has as its forward end an inwardly tapered terminator electrode receiving section **64** spaced from the innermost edge **66** of arc snuffer **52.** The receiving section is slitted with two diametrically spaced slits **70** extending from the receiving mouth end **72** to a line near its body portion **62.** The slits produce a resilient mouth end, the mouth end terminating in an out-turned lip **74** which serves as a retainer for the holding ring or washer **76.** Ring **76,** which may be fabricated of tin-plated metal, is fitted about the outside of the female contacting member **60** adjacent its mouth end to limit the expansion of this slitted end of the contacting member in response to spreading forces.

The copper tube or shell **34** tapers outwardly in a rearward direction from body section **38** through the tapered section **40** to the enlarged end section **42.** Section **4** is of length slightly longer than its diameter, its inner diameter being approximately twice that of snuffer tube **52.** Section **42,** in turn, leads to the inturned rearmost end **44** of shell **34.** Within end **44** is mounted an end plug **80** of cylindrical shape sized to fit tightly within the shell end. The end plug **80** has a body of some thickness which may be copper or the like and has a threaded bore **82,** coaxial with the shell axis. In fabrication of the shell **34,** the end plug may be inserted within section **42** and the remote end **44** formed over the curved edge **84** of the plug to firmly lock the end plug in place, leaving the bore **82** open for connection to a conductive stud (not shown).

End plug **80** has a toroidal slot **90** in its inner wall **92,** the slot **90** being concentric about the bore **82.** By providing slot **90** in the otherwise smooth plug surface, we provide a configured or roughened wall in the path of a pressure wave to break up the wave and thereby aid in diffusing the generated pressure. To enhance these effects, we further use slot **90** to seat one end of a tubular screen member **94.** Screen member **94** may comprise a length of fine mesh screening rolled or coiled into a tight cylindrical tube **96** having a number of thicknesses of screen comprising the wall thickness of the cylindrical tube.

We have found that a screen of **20** square mesh, 0.015 inch diameter wire, preferably copper, with a plurality of thicknesses wound into tubular form performs quite satisfactorily. Further, we have found that even superior pressure relieving characteristics result if we plate the screen with a plating of a metal of the transition metal grouping such as nickel, platinum, or palladium, the plating being up to 0.001 inch thick.

As mentioned in the preferred form, we use a spirally wound tube, and to hold the spiral screen together, one

end of the screen tube may have angularly spaced soldered points joining the screen thicknesses together. The tube rests within the torodial slots **90** and extends for virtually the entire length of body shell section **42**, a distance which may approximate one and a half inches or more.

The principle of operation of our invention may be summarized as follows: When a circuit between the electrode **14** of the terminator and the receiving electrode **60** is either being opened or closed, an arc is generated which will be partially suppressed by the arc follower **18** and the snuffer **52.** Such an arc will tend to generate a high pressure wave within the connector shell cavity. This wave will pass down the shell and will enter the expanded cavity section **42** and will thereby be somewhat reduced in intensity. The wave will also reach the screen **94.** The large available surface area on the screen will buffer the pressure wave. In addition, the many screen sheet ends confronting the wave will even further buffer and diffuse the pressure wave. The screen will tend to condense and cool the gas on its multiplicity of surfaces. Further, the configured nature of the screen in conjunction with the slotted face of end plug **82** will soften and break-up the shock wave. While other screen configurations are possible, we find that a single spiral sheet wound into a multiple thickness tube provides excellent shock wave dissipation and condensation of the gas pressure wave. With the pressure dissipated and the gas cooled, the circuit may be readily closed or opened in the energized condition with no adverse reaction to the intended action.

As mentioned previously, we find that by plating the sheet of screen **94** with either nickel, platinum or palladium prior to assembly, the plating material acts as a catalyst to speed the condensation and cooling of the gas on the screen mesh.

In FIG. **6,** we show an added feature of our invention. In this figure, we show a connector similar to that of the prior FIGS. **1–5,** with its outer dielectric housing **32,** a copper shell **34,** a screen tube **96** and a modified receiving electrode **160** corresponding to receiving electrode **60** of the first embodiment.

The receiving electrode **160** adjacent its inward end has a section internally threaded as indicated by the reference character **161.** Mated with the threading **161** is an externally threaded scraping member **163.** Member **163** is threaded into the connector and presents its bore **165** to the arc follower rod **18** of the terminator. The bore **165** is tapered from its minimum diameter **167** at the end adapted to receive the follower rod **18** and the bore tapers outwardly therefrom. The minimum diameter **167** is sized to provide an interference fit with the follower of approximately 0.002 inch to 0.004 inch at diameter **167.** The maximum diameter at the rear end of the scraper bore may be in the range of 0.010 inch clearance fit. Thus, the scraper receives the rod tightly and scrapes from the rod all contaminants.

If contaminants or adhering bits of conductive material or dielectric material are picked up by the rod inwardly of the minimum diameter edge of the scraper member, they will be scraped off the rod during its movement toward the position of FIG. **1.** Thus, the rod will be scraped clean during its removal and the contaminants fall backwardly down the tapered bore and, thus, will not add to the arc length or draw the arc to even longer lengths than its voltage would indicate. The scraping action further tends to minimize the arc and thereby reduce the pressure in the connector cavity. Preferably, the scraping member is fabricated of arc suppressant dielectric material similar to that of arc follower **18** and snuffer **52.**

While there has been described what is at present thought to be the preferred embodiments of the invention, it is understood that modification may be made therein, and it is intended to cover in the appended claims all such modifications which fall within the true spirit and scope of the following claims.

We claim:

**1.** A connector for receiving a load break terminator having a central conductive electrode, said connector comprising an electrode for receiving said terminator electrode through an open face at one end of said connector and for engaging said terminator electrode to complete a current transmitting path therebetween,

a conductive body in said connector for completing a heavy power transmitting path from said receiving electrode to a connecting member at the remote end of said connector,

a housing surrounding said conductive body to enclose said conductive body and produce an otherwise closed cavity therein,

an arc suppressant member adjacent the open face of said connector for receiving said terminator electrode prior to entry and after removal of the terminator electrode from the receiving electrode, said body, including a sidewall tapering from said open face end to produce a flow path of successively increasing section, a pressure relieving member within said conductive body cavity, said relieving member comprising a tubular member of mesh screen,

means positioning said member said body cavity substantially concentrically within said flow path adjacent said remote end to receive and condense a pressure wave generated by an arc during entry or removal of said terminator from said connector.

**2.** A connector as claimed in claim **1,** wherein said tubular member comprises a metallic, mesh screen wound spirally into tubular form.

**3.** A connector as claimed in claim **1,** wherein said tubular member is fabricated of a sheet of fine mesh copper screening configured into tubular form.

**4.** A connector as claimed in claim **1,** wherein said tubular member comprises a copper mesh screen tube plated with a transition metal.

**5.** A connector as claimed in claim **3,** wherein said tubular member comprises a nickel-plated sheet of screen material.

**6.** A connector as claimed in claim **3,** wherein said tubular member comprises a platinum-plated sheet of screen material.

**7.** A connector as claimed in claim **3,** wherein said tubular member comprises a palladium-plated sheet of screen material.

**8.** A connector as claimed in claim **1,** wherein there is interposed between said connector and said tubular member

a tubular scraping edge of dielectric material axially aligned in said cavity to engage the arc follower in surface contact therewith, and

a surface positioned to deposit material scraped from said follower adjacent said screen.

9. A receiving connector for a load break terminator having

a central conductive, rod-shaped electrode with an arc follower at the exposed end thereof,

said connector comprising an annular receiving electrode for receiving said terminator electrode through an open face at one end of said connector and for engaging said terminator electrode to complete a current transmitting path between said electrodes,

a conductive body in said connector for completing a heavy power transmitting path from said receiving electrode to a connecting member at the remote end of said bushing,

a housing surrounding said conductive body to enclose said conductive body and produce an otherwise closed cavity therein,

an arc suppressant member adjacent the open face of said connector for receiving said terminator electrode prior to entry and after removal of the terminator electrode from the receiving electrode,

and a pressure relieving member within said conductive body cavity,

and a scraping member disposed coaxially of said receiving electrode,

means mounting said scraping member inwardly of said receiving electrode in position to engage said terminator electrode and follower,

said scraping member comprising a ring sized to interferingly receive the arc follower and scrape materials therefrom,

said scraper member tapered from said ring to deposit scraped materials rearwardly of said receiving electrode.

10. A connector as claimed in claim 9, wherein said scraper ring is fabricated of dielectric, arc-suppressant material.

11. A receiving connector for a load break terminator having a central conductive electrode, said connector comprising an electrode for receiving said terminator electrode through an open face at one end of said connector and for engaging said terminator electrode to complete a current transmitting path therebetween, a conductive body in said connector for completing a heavy power transmitting path from said receiving electrode to connecting member at the remote end of said connector, a housing surrounding said conductive body to enclose said conductive body and produce an otherwise closed and walled cavity therein, an arc snuffing member adjacent the open face of said connector for receiving said terminator electrode prior to entry and after removal of the terminator electrode from the receiving electrode, the walls of said cavity positioned to channel a pressure wave generated by an arc toward said remote end during entry or removal of said terminator from said connector, and means within said conductive body cavity for condensing and diffusing a pressure wave, said last-mentioned means comprising a contoured member contained inwardly of the axial extension of the walls of the cavity and extending into said cavity from said remote end within the path of the pressure wave to diffuse the generated pressure wave channelled thereto.

12. A connector as claimed in claim 11, wherein said snuffing member comprises a tubular member of polyoxymethylene with structural filler material.

13. A connector as claimed in claim 12, wherein said structural filler material is a glass fiber filler.

14. A connector as claimed in claim 11, wherein said glass fiber filler is borosilicate.

15. A connector as claimed in claim 11, wherein said condensing and diffusing means comprises an enlargement in said cavity with an inner diameter at least twice that of the bore of said snuffing member.

16. A connector as claimed in claim 15, wherein said condensing and diffusing means comprises a configured end face of said cavity confronting any pressure wave generated in said connector cavity.

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