

- [54] **DIELECTRIC SHIELD FOR PLUG-IN CONTACTS**
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[22] Filed: **April 26, 1971**
[21] Appl. No.: **137,322**
[52] U.S. Cl. **339/64 R, 339/255 R**
[51] Int. Cl. **H01r 13/62**
[58] Field of Search..... **339/64, 255**

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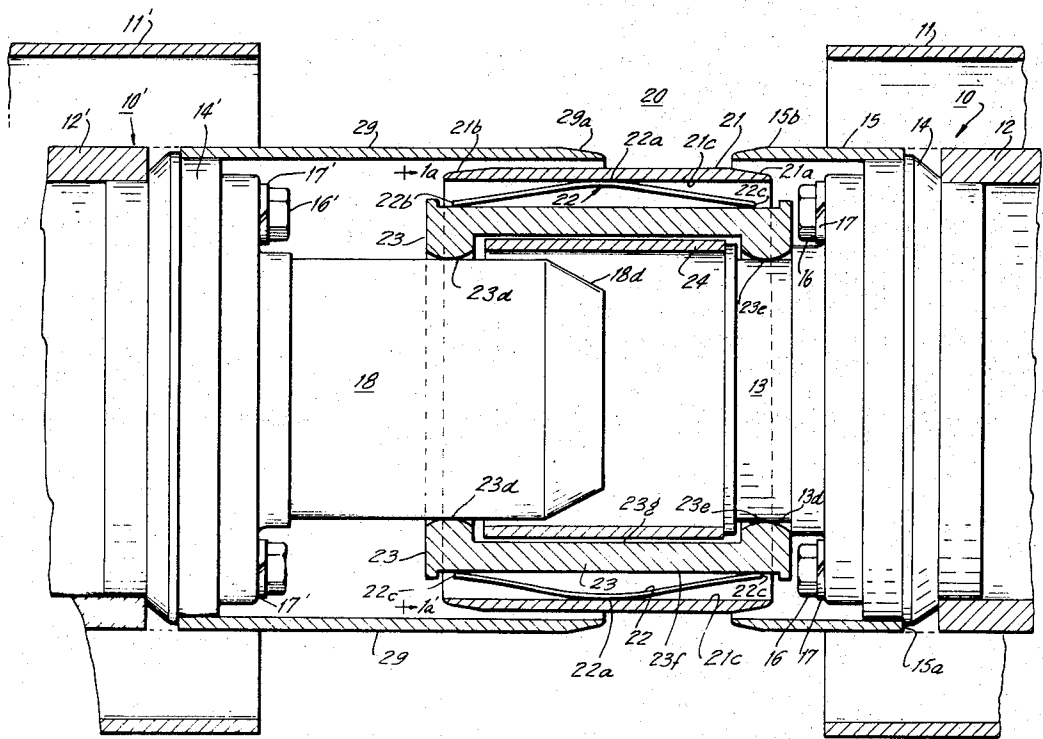
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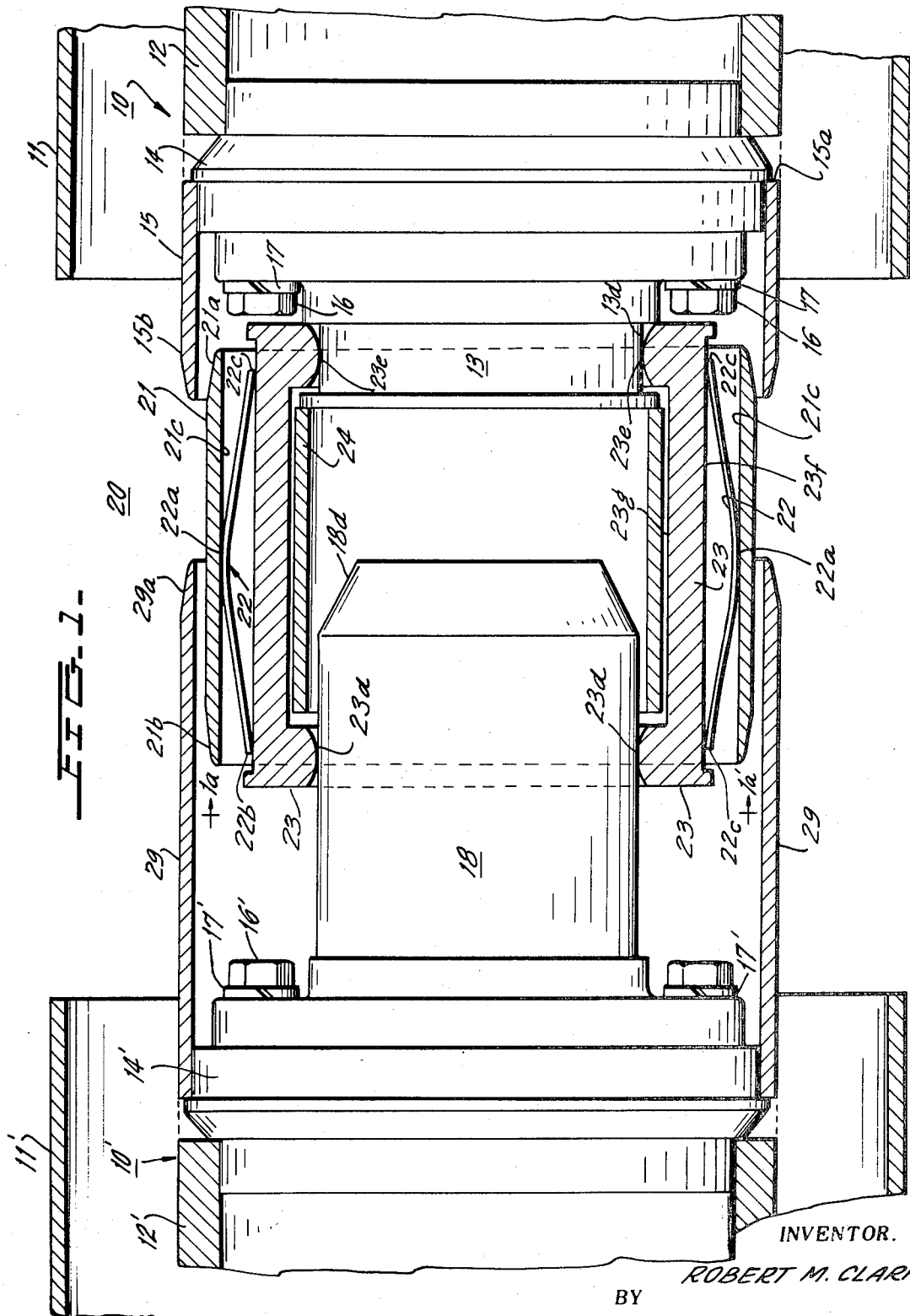
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[57] **ABSTRACT**

Inner conductors of isolated phase bus sections arranged end-to-end are adapted to experience movement relative to one another due to normal expansion and contraction thereof by virtue of a dielectric shielding assembly in which a multiplicity of contact fingers are biased against one end of one of the central conductors so as to ride in a groove provided therefor while being biased against the end of the next adjacent conductor so as to make slidable contact engagement therewith. A dielectric shield surrounds both the ends of the conductors and the multiplicity of contact fingers and supports biasing members for urging the contact fingers and the central conductor members into intimate electrical contact while at the same time serving the dual function of providing a dielectric shield to reduce electrical stresses which occur due to the contraction and expansion of the central conductors.

9 Claims, 7 Drawing Figures





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FIG. 1a-

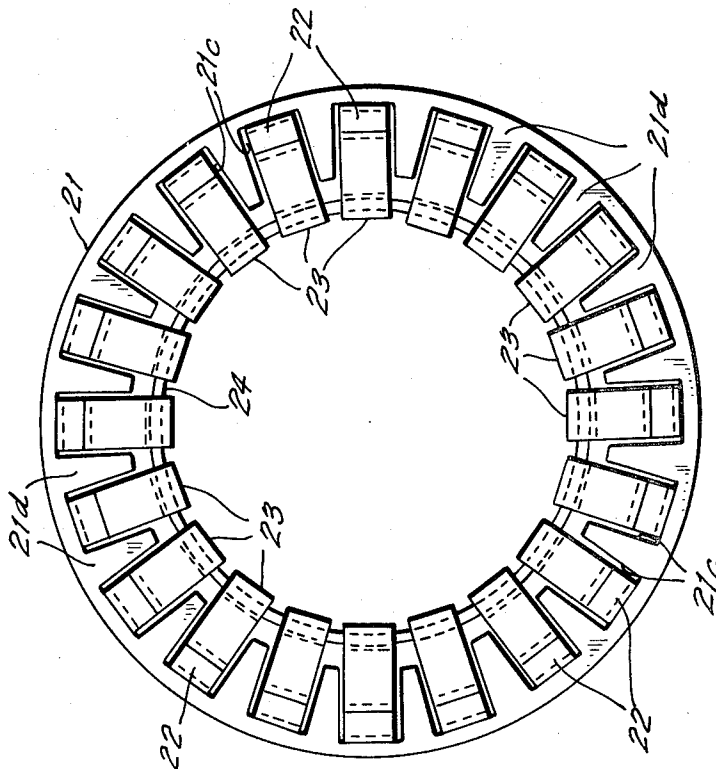
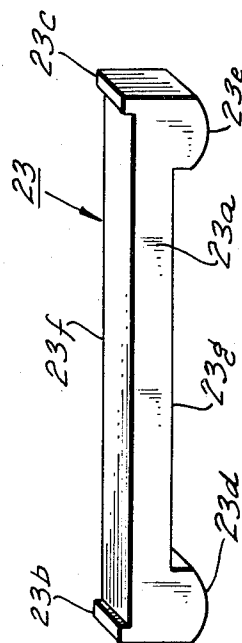
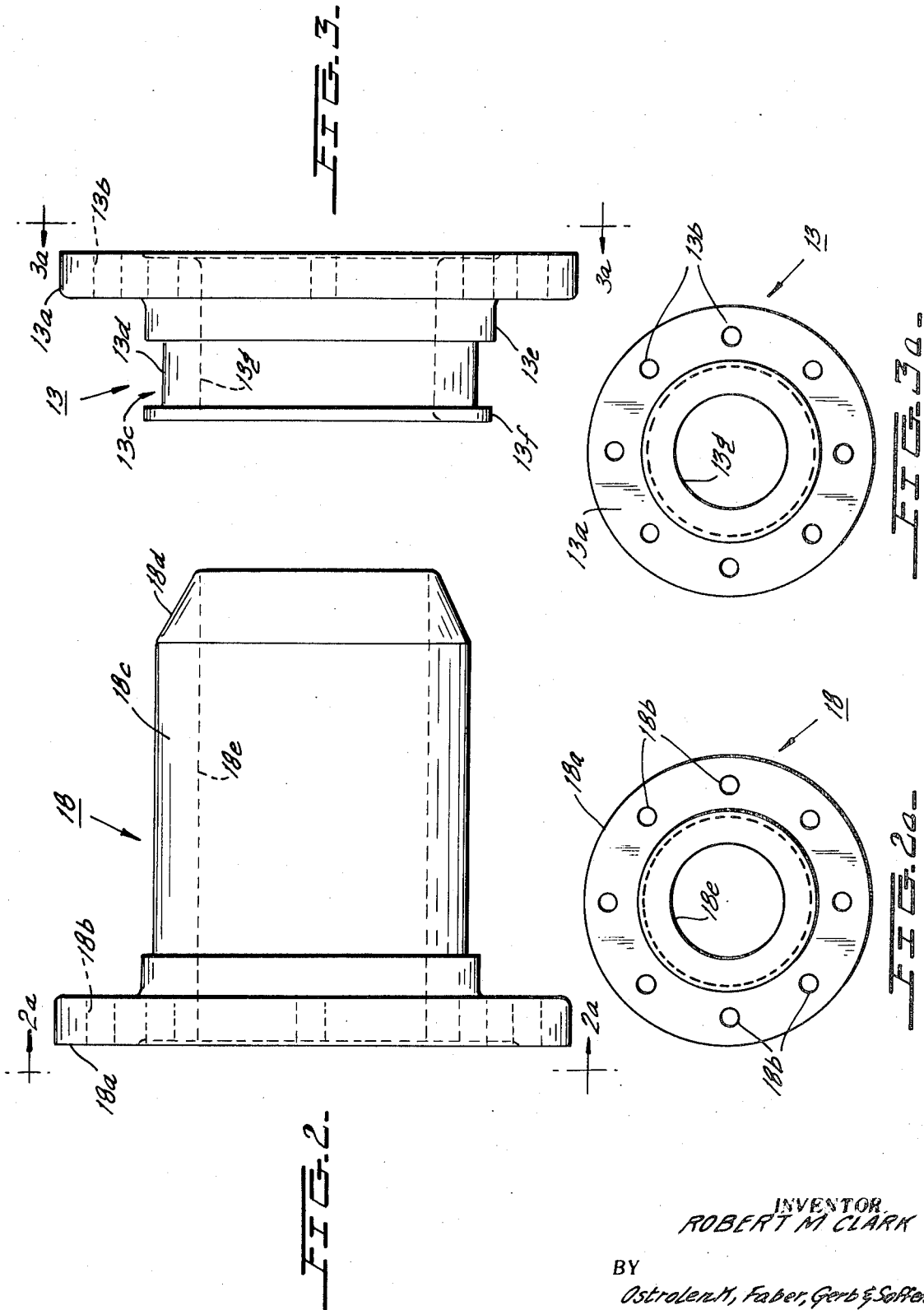


FIG. 4-



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DIELECTRIC SHIELD FOR PLUG-IN CONTACTS

The present invention relates to isolated phase bus employed in the power transmission and distribution field and more particularly relates to a novel connector assembly serving the dual function of providing electrical engagement between relatively movable central conductors arranged in end-to-end fashion while at the same time providing excellent dielectric shielding which reduces electrical stress which would otherwise occur as a result of contraction and expansion of the conductor.

Isolated phase bus systems find widespread use in the electrical power field and are typically employed for the transmission and distribution of electrical power at extremely high voltages and currents. One of the advantages of such systems is the capability of carrying electrical power at extremely high voltage and current ratings while at the same time occupying much less space as compared with conventional transmission and distribution lines.

Such isolated phase bus systems are normally comprised of a central conductor of tubular design positioned and supported within a surrounding conductive housing maintained concentric with the central conductor by means of insulating spacers arranged at spaced intervals along the bus sections.

A bus run is typically comprised of a plurality of bus sections mechanically and electrically connected in end-to-end fashion so as to service the particular installation over its entire length. Each of the sections are joined by suitable conductive structures to maintain and preserve the conductive paths along the entire bus run. The central conductors are usually connected by flexible conductive straps capable of experiencing expansion and/or contraction commensurate with the amount of expansion and/or contraction generally experienced by the bus when in operation. Expansion and contraction of the bus sections is typically caused by temperature changes due to ambient temperature conditions as well as heating and/or cooling of the bus members as they carry more or less current therethrough.

In bus sections of the type described hereinabove a high dielectric stress occurs at the surface of the inner or central conductor. As the conductor contracts and expands, a gap is created between the conductors, which gap is of greater or lesser length resulting in higher voltage gradients at the exposed edges of the spaced adjacent conductor ends. Since the current voltage ratings are extremely high, the dielectric stress is capable of causing severe damage to the bus run. One technique for controlling dielectric stress is to fill the enclosure with a compressed gas such as sulfurhexafluoride (SF_6). However, this technique has not completely resolved the problems of dielectric stress.

The present invention is characterized by providing a novel contact assembly which serves the dual function of providing and maintaining the integrity of the conductive path between adjacent central conductors arranged in end-to-end fashion while at the same time incorporating a dielectric shield for controlling the electrical stresses encountered while at the same time serving as the means for supporting the contact fingers and urging same into intimate electrical contact with the associated inner conductors.

The present invention is comprised of first and second plug members which are mechanically and electrically connected to the ends of adjacent central conductors provided within an isolated phase bus system. The first of said plugs is provided with an annular groove adjacent its free end while the second of said plugs is provided with a cylindrical shaped projection of reduced diameter as compared with the diameter of the central conductors being electrically joined. First and second hollow cylindrical projections are secured to the adjacent central conductors so as to substantially surround each of their associated plug members. A metallic dielectric shield is positioned so as to at least partially overlap the free ends of the plug members and so as to have each of its ends partially surrounded by an associated one of the aforementioned tubular conductive envelopes. The interior surface of the dielectric shield is provided with a plurality of axially aligned slots each being adapted to receive an associated biasing member and contact finger. The contact fingers are provided with projecting portions at each of their free ends. The projecting portions at one end of the contact fingers are received by the aforementioned annular groove while the projecting end portions at the opposite end of the contact fingers are adapted to make wiping or sliding engagement with the aforementioned cylindrical projection. No fastening means whatsoever are required for mounting or positioning the dielectric shield assembly. The wiping or sliding engagement of the contact fingers with the cylindrical projection allows for normal expansion and contraction between the central conductors of the isolated phase bus system. However, the combined dielectric shield and contact finger assembly is maintained substantially stationary enabling the first and second cylindrical envelopes and the cylindrical shaped dielectric shield to cooperatively serve to maintain the electrical field pattern in the region of the joined inner conductors regardless of the amount of relative movement between the joined electrical conductors.

It is therefore one object of the present invention to provide a novel combined dielectric shield and contact finger assembly for electrically joining central conductors of an isolated phase bus system while maintaining the dielectric stress pattern regardless of any relative movement which may occur between the electrically joined inner conductors.

Another object of the present invention is to provide a novel combination dielectric shield and contact finger assembly comprised of a cylindrical shaped shield member having means for receiving an associated biasing member and contact finger which is adapted to electrically engage the free end of the conductors to be joined so as to eliminate any need whatsoever for conventional fastening means.

These as well as other objects of the present invention will become apparent when reading the accompanying description and drawings in which:

FIG. 1 is an elevational view, partially sectionalized, of a portion of an isolated phase bus system employing the novel dielectric shield and electrical contact assembly of the present invention;

FIG. 1a is an end view of the dielectric shield and contact finger assembly of FIG. 1 looking in the direction of arrows A-A';

FIGS. 2 and 2a are side and end views, respectively, of one of the plug connectors employed in the embodiment of FIG. 1;

FIGS. 3 and 3a are side and end views, respectively, showing the remaining plug connector of the embodiment of FIG. 1; and

FIG. 4 is a perspective view showing one of the plurality of contact fingers of FIG. 1 in greater detail.

Referring now to the drawings, FIG. 1 shows portions 10 and 10' of first and second isolated phase bus runs which may either be one phase of a multi-phase system or may be the bus sections of a single phase isolated phase bus system. Obviously, in the case of multi-phase isolated phase bus systems (such as, for example, three phase systems) each of the sections (and the connectors therefor, to be more fully described hereinbelow) will be of similar design and hence a description of multi-phase systems has been eliminated herein for purposes of simplicity.

Each of the bus sections 10 and 10' is comprised of a conductive tubular shaped enclosure 11 and 11' surrounding and concentrically aligned with a central conductor 12 and 12', respectively. Central conductors 12 and 12' are maintained in the concentric alignment by means of insulating spacers which are arranged at spaced intervals along each bus section and which have been omitted herein for purposes of simplicity. Detailed descriptions of typical bus sections are set forth in U.S. Pat. Nos. 3,573,342 and 3,573,341, both issuing on Apr. 6, 1971 and assigned to the assignee of the present invention. The relative spacing between inner and outer conductors 10-11 and 10'-11' have been reduced as shown in FIG. 1 merely for purposes of simplicity. The housings 11 and 11' of the adjacent housing sections are mechanically and electrically joined to one another and by suitable enclosure means described in detail in U.S. Pat. No. 3,573,342 and a description thereof will be omitted herein for purposes of simplicity, the teachings of these patents being incorporated herein by reference thereto.

A first plug connector 13 is secured to the left-hand end of central conductor 12 which is provided with an end plate 14 which may be secured in any suitable fashion to conductor 12, such as, for example, by welding. A short, hollow cylindrical section 15 is also secured to end plate 14, also preferably by welding and is arranged so as to substantially envelop plug connector member 13. The weldment may be provided along the right-hand peripheral edge 15a of cylindrical conductive member 15.

The plug 13, shown best in FIGS. 1, 3 and 3a, is comprised of a flange portion 13a having a plurality of spaced apertures 13b each adapted to receive a threaded fastening member 16 which engages openings (not shown for purposes of simplicity) provided within the end closure member 14. The flange portion is provided with a projecting portion 13c of reduced diameter which portion is provided with an annular groove 13d bordered on both of its sides by raised diameter portions 13e and 13f, respectively. Member 13 is further provided with a central opening 13g.

The right-hand end of central conductor 12' is provided with a similar enclosure member 14' welded or otherwise joined to the right-hand end of the conductor 12' in a fashion similar to that described in connection

with enclosure member 14. A second plug connector 18, shown best in FIGS. 1, 2 and 2a, is comprised of a flange portion 18a having a plurality of apertures 18b arranged around its periphery for receiving threaded fastening members 16' which threadably engage tapped openings (not shown for purposes of simplicity) in end enclosure 14' to secure member 18 thereto. The enlarged diameter portion 18a of plug connector 18 is provided with a reduced diameter projection 18c whose free end is bevelled at 18d. The plug connector is provided with a central opening 18e. Each of the threaded fastening sets 16 and 16' are provided with washers 17 and 17', respectively, to rigidly lock the tightened fasteners in position. Conductive tubular member 29 is joined to end plug 14', preferably by welding.

The combined contact finger and dielectric shield assembly 20, shown best in FIGS. 1, 1a and 4, is comprised of a substantially cylindrical shaped dielectric shield member 21 having a smooth substantially circular outer surface which is tapered or bevelled in the vicinity of its free ends 21a and 21b. The interior of conductive shield member 21 is provided with a plurality of axially aligned recesses 21c arranged at regularly spaced intervals about the interior surface thereof. Each of the recesses is defined by a pair of spaced radially aligned projections 21d.

Each recess 21c receives and positions an elongated arcuate shaped spring member 22 with each spring being positioned with the convex surface of its central portion 22a engaging the base portion of its associated recess 21c. The free ends 22b and 22c of each spring member are arranged to bear against a conductive contact finger 23, shown best in FIGS. 1, 2 and 4. Each contact finger is a solid copper member, preferably silver plated and having an elongated body portion 23a provided along its outer surface with first and second projections 23b and 23c and provided along its inner surface with a pair of projections 23d and 23e whereby each of the projections 23d and 23e is provided with a curved contact surface. Each of the contact finger structures are positioned so as to have the free ends of their associated spring members bearing against outer surface 23f in the manner shown best in FIGS. 1 and 1a. The projections 23b and 23c limit the amount of relative movement between the contact fingers and their associated biasing springs.

The dielectric shield-contact finger assembly is further comprised of an inner hollow, cylindrical shaped member 24 positioned in the manner shown best in FIG. 1, so as to have its outer surface engage the surfaces 23g of all of the contact fingers 23. The inner edges of projections 23d and 23e limit the amount of relative movement which may occur between the contact fingers and inner cylindrical member 24.

The assembly steps of the dielectric shield-contact finger structure may, for example, be as follows:

Inner cylindrical member 24 is positioned within outer cylindrical member 21 so as to occupy the relative positions as shown best in FIG. 1. Each contact finger may then be slipped into one of the associated slots 21c either together with a biasing spring member or they may be first slipped in with the biasing spring member being slipped in thereafter until all of the contact fingers and biasing springs have been so inserted.

The biasing springs urge their associated contact fingers inwardly toward the inner cylindrical member 24. The diameter of cylindrical member 24 is such as to maintain the biasing members under compression thereby holding each of the contact fingers in position.

The mounting of the structure may be performed as follows:

The plug connector 18 is first mounted to the end closure member 14'. Thereafter the dielectric shield-contact finger assembly is slipped over the cylindrical projecting portion 13c of plug connector 13. The cylindrical enclosure 15 which is preferably secured to end closure 14 by welding, is then mounted (either before or after mounting of assembly 20) so as to occupy the position as shown best in FIG. 1.

Plug connector 18 is then mounted to enclosure 14 either before or after mounting of the conductive cylindrical member 29 to the end connector 14'. The bus section comprised of conductor 10' and 11' is then moved toward the right so as to cause each of the projections 23e to make wiping engagement with projection 18c. Bevelled end 18d facilitates this operation. It should be noted that the sequential steps set forth hereinabove are merely exemplary and that the assembly steps may be modified accordingly to suit the needs of the particular installation.

The cylindrical members 15, 21 and 29 cooperatively form a dielectric shield arrangement which effectively electrically "seals" the gap between the end conductors 12 and 12'. The left-hand end 15b of member 15 and the right-hand end 29a of member 29 are preferably tapered or bevelled in the manner shown. It can be seen that the members 15, 21 and 29 form a dielectric shield which substantially completely embraces the gap between inner conductors 12 and 12'.

Any relative movement between inner conductors 12 and 12' is fully compensated for by means of the contact finger assembly. For example, let it be assumed that the left-hand end of inner conductor structure 12 is maintained stationary while the right-hand end of inner conductor 12' experiences either expansion or contraction as a result of heating or cooling thereof. Plug connector 18, being fixedly secured to the right-hand end of inner conductor 12' will thereby experience linear movement either toward the left or toward the right. Although this linear movement will be permitted by the contact finger assembly, the left-hand projections 23d of contact finger 23 will be maintained in firm engagement with the peripheral surface of projection 18c so as to provide an electrical path extending from inner conductor 12, end connector 14, plug connector 13, contact fingers 23, plug connector 18, and end connector 14' to the inner conductor 12'.

The contact finger assembly is prohibited from experiencing any significant linear movement relative to plug connector 13 as a result of the seating of projections 23e within annular groove 13d. It should be noted that the sliding electrical engagement will be maintained between contact fingers 23 and plug connector 18 in the case where plug connector 18 is maintained stationary and plug connector 13 experiences linear movement relative thereto. Thus, regardless of any relative linear movement as between inner conductors 12 and 12', the contact finger assembly as well as the shields 15, 21 and 29 remain substantially stationary

relative to one another so as to maintain the integrity of the dielectric shield as well as maintaining the integrity of the electrical path between the inner conductors 12 and 12'.

Due to the design of the dielectric shield-contact finger assembly, it should further be noted that the contact finger assembly will provide an effective electrical path between the plug connectors 13 and 18 even in the case where there is a slight axial misalignment therebetween. In addition thereto it should further be noted that the assembly 20 requires no additional fastening means of conventional design for coupling between the plug connectors thereby greatly facilitating both assembly of the contact finger structure and mounting to the plug connectors.

It can thus be seen from the foregoing description that the present invention provides a novel dielectric shield-contact finger assembly which maintains the integrity of both the dielectric shield structure and the electrical conductive path between a pair of spaced inner conductors regardless of any relative movement therebetween which occurs as a result of normal expansion and/or contraction of the conductors when in use.

Although there has been described a preferred embodiment of this novel invention, many variations and modifications will now be apparent to those skilled in the art. Therefore, this invention is to be limited, not by the specific disclosure herein, but only by the appending claims.

I claim:

1. A conductor assembly for electrically joining the adjacent spaced ends of first and second annular shaped conductors of substantially equal diameter surrounded by an annular shaped conductive housing comprising:

a first annular shaped hollow conductive shell having a diameter less than the diameter of said first and second conductors;

a plurality of elongated contact fingers being axially arranged at spaced intervals about the interior of said first shell;

means provided along the interior of said first shell and engaging said first shell and said contact fingers for maintaining each of said contact fingers at spaced intervals around the inner periphery of said first shell and for urging each of said fingers inwardly and away from the interior surface of said shell;

a second annular shaped shell of a diameter less than the diameter of said first shell being substantially coaxially aligned with said first shell and being positioned within said first shell and surrounded by said contact fingers to limit the inward movement of all of said contact fingers toward the longitudinal axis of said second shell and thereby maintain said first and second shells and said contact fingers in their relative positions without the need for conventional fastening means;

said contact fingers each having a pair of inwardly directed contact portions at each of their free ends, the inner ends of said portions abutting the opposing ends of said second shell to limit the linear movement of said contact fingers relative to said second shell, said contact portions extending inwardly toward the longitudinal axis of said

second shell and beyond the inner surface of said second shell;

each of the adjacent ends of said first and second conductors having an axial conductive projection of reduced diameter for engaging the conductive surfaces at associated free ends of each of said contact fingers;

a first one of said projections having an annular groove for receiving and seating the associated contact surfaces at one free end of said contact fingers to substantially prevent linear movement of said contact fingers relative to said annular groove while the remaining contact surfaces make sliding engagement with their associated projection to maintain good electrical engagement therebetween while enabling relative movement between said first and second conductors;

said first shell being positioned to overlap at least a portion of each of said projections to provide good dielectric shielding for the region between said first and second conductors regardless of any movement of said first and second conductors.

2. The assembly of claim 1 wherein said second shell telescopically receives the free end of at least the remaining one of one of said projections carried by said first and second conductors.

3. The assembly of claim 1 wherein said positioning means is comprised of a plurality of axial recesses arranged at spaced intervals around the interior surface of said first shell for receiving an associated one of said contact fingers.

4. The assembly of claim 1 wherein said positioning means is comprised of a plurality of axial recesses arranged at spaced intervals around the interior surface of said first shell for receiving an associated one of said contact fingers; biasing members being positioned in each of said recesses for urging each of their associated contact fingers toward engagement with said projections.

5. The assembly of claim 4 wherein said biasing members are each comprised of elongated arcuate shaped leaf springs having their central portions engaging its associated recess and having their free ends engaging their associated contact fingers.

6. The assembly of claim 5 wherein each of said contact fingers is provided with a pair of projections at their free ends to limit the relative linear movement between each contact finger and its associated spring.

7. The assembly of claim 1 further comprising a third hollow conductive shell having a first end secured to one free end of one of said first and second conductors and telescopically receiving one end of said first shell so as to overlap at least a portion of said first shell.

8. The assembly of claim 1 further comprising a fourth hollow conductive shell having a first end secured to one free end of the remaining one of said first and second conductors and telescopically receiving the remaining end of said first shell so as to overlap at least a portion of said first shell, whereby said first, third and fourth shells cooperate to provide a dielectric shield substantially completely enveloping the gap

between said first and second conductors to maintain the dielectric integrity of the structure in the region of the gap regardless of any relative movement of said first and second conductors.

9. A conductor assembly for electrically joining the adjacent spaced ends of first and second annular shaped conductors of substantially equal diameter surrounded by a spaced annular shaped conductive housing comprising:

a first annular shaped hollow conductive shell of a diameter less than the diameter of said first and second conductors;

a plurality of elongated contact fingers being axially arranged at spaced intervals about the interior of said shell;

means provided along the interior of said first shell for positioning each of said contact fingers and urging each of said fingers inwardly and away from the interior surface of said shell;

a second annular shaped shell of a diameter less than the diameter of said first shell being positioned within said first shell and being surrounded by said contact fingers to limit the inward movement of all of said contact fingers;

said contact fingers having a pair of inwardly directed contact surfaces at each of their free ends which limit the linear movement of said contact fingers relative to said second shell;

each of the adjacent ends of said first and second conductors having an axial conductive projection of reduced diameter for engaging the conductive surfaces at associated free ends of each of said contact fingers;

a first one of said projections having an annular groove for receiving and seating the associated contact surfaces at one free end of said contact fingers to substantially prevent linear movement of said contact fingers relative to said annular groove while the remaining contact surfaces make sliding engagement with their associated projection to maintain good electrical engagement therebetween while enabling relative movement between said first and second conductors;

said first shell being positioned to overlap at least a portion of each of said projections to provide good dielectric shielding for the region between said first and second conductors regardless of any movement of said first and second conductors;

each of the adjacent ends of said first and second conductors further including hollow conductive cylindrical portions of a diameter equal to said first and second conductors and projecting outwardly from and electrically connected to their conductors and extending toward one another;

the ends of said first shell being adapted to be telescopically received by and within the free ends of said hollow cylindrical shells to cooperatively form a dielectric shield to reduce electrical stresses in the joining region between said adjacent conductors.

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