June 18, 1946. G. L. McCUTCHAN 2,402,503

SHIELDED ELECTRICAL CONDUCTOR CONSTRUCTION AND METHOD OF MAKING THE SAME

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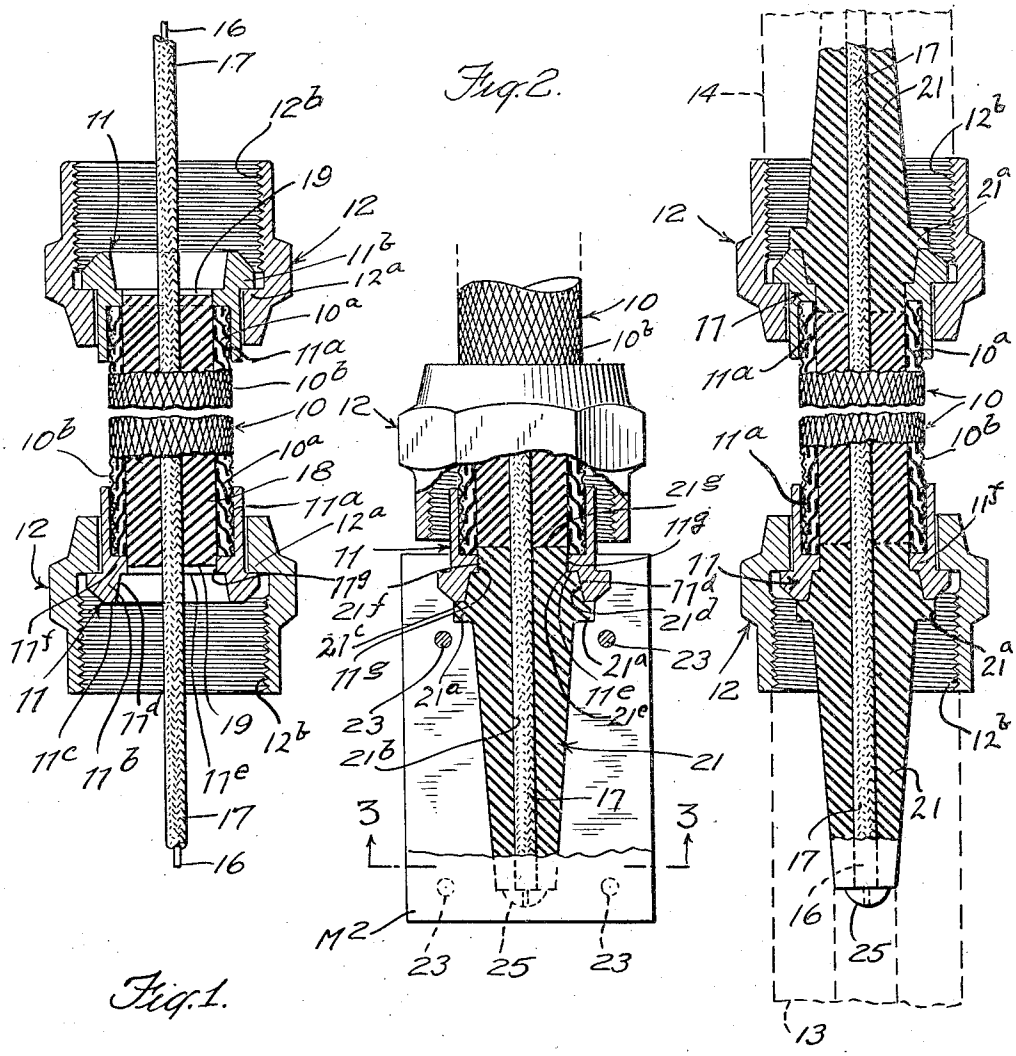


Fig. 1.

Fig. 2.

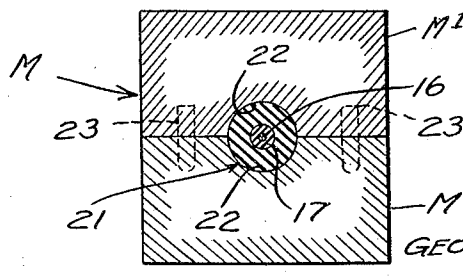


Fig. 3.

Fig. 4.

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SHIELDED ELECTRICAL CONDUCTOR CONSTRUCTION AND METHOD OF MAKING THE SAME

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This invention relates to radio-shielded electrical conductor and terminal or connector construction, more particularly of the kind sometimes known as radio-shielded spark plug leads such as are employed in extending the electrical circuit connections from the manifold to individual spark plugs in internal combustion engines, and to a method of making the same.

One of the objects of this invention is to provide a practical and reliable radio-shielded spark plug lead construction that will dependably stand up under the widely varying conditions of practical use, that will be capable of advantageous manufacture and assembly, and that will effect reliable and long-lasting sealing against seepage thereinto of moisture, vapors, gases, or the like. Another object is to provide a practical and efficient radio-shielded conductor and terminal construction. Another object is to provide a construction of the above character in which reliable leak-proof junctions between terminal insulator and filler compound in the shielding conduit may be achieved in a thoroughly practical manner well adapted for quantity production. Another object is to provide a construction of the above-mentioned character in which insulating materials of different physical properties may be employed for the terminal insulator and for the insulating compound filling the space between the conductor and the shielding conduit in a manner so that the purposes and functioning of the one may not be detrimentally affected by the other. Another object is to provide a construction of the above-mentioned character in which the terminal insulator is of a consistency or hardness to have resiliency appropriate to function as a gasket, while the insulating or filler compound in the shielding conduit is of soft consistency, the two being sealed or joined together in such a manner that the gasket characteristics of the terminal insulator are not impaired by the softer material. Another object is to provide a simple, practical, and efficient method for making radio-shielded conductors with terminal insulators. Another object is to provide a method for dependably assembling and sealing a radio-shielded conductor with filler compound and a terminal insulator having certain physical properties and functions different from those of the filler, all without impairment of the properties of the one by the properties of the other. Another object is, in general, to provide an improved method and construction of the above-mentioned nature, and other objects will be in part obvious or in part pointed out hereinafter.

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The invention, accordingly, consists in the features of construction, combinations of elements, arrangement s of parts, and in the several steps and relation and order of each of the same to one or more of the others, all as will be illustratively described herein, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing, in which is shown, by way of illustration, a preferred embodiment of the mechanical features of my invention,

Fig. 1 is a central longitudinal sectional view, certain parts being shown in elevation and being partly broken away, of a radio-shielded conductor structure in one stage of its construction according to my method;

Fig. 2 is an elevation, partly in longitudinal cross-section, showing the construction in a succeeding stage;

Fig. 3 is a transverse sectional view along the line 3—3 of Fig. 2; and

Fig. 4 is a central longitudinal sectional view, certain parts being shown in elevation and certain parts being broken away, or indicated in broken lines, showing the completed shielded conductor and terminal construction.

Similar reference characters refer to similar parts throughout the several views of the drawing.

Referring, first, to Fig. 1, I preferably employ a conduit, generally indicated by the reference character 10, which, for purposes of effecting radio-shielding, is metallic and preferably comprises a flexible tube 10a made of helically wound, corrugated, strip sheet-metal, such as is shown in United States Patent No. 1,198,392, employing, if desired, suitable means, such as solder, for achieving improved tightness and strength, in the manner shown and described in United States Patent No. 2,127,943, and preferably a covering 10b of braided metal strands, as shown and described in United States Patent No. 1,340,818, snugly envelops the flexible tubing 10a, being, of course, flexible therewith. The ends of the conduit 10 are received in suitable counter-bores 11a of a suitably shouldered ferrule 11, to which they are secured in any suitable way to effect a sealed connection, for example, as by soldering. The ferrules 11 have shoulders or flanges 11b, with which engage the end shoulders 12a of nuts 12, internally threaded as at 12b, whereby the respective ends of the conduit 10 and related parts, later described, may be secured, for example, to the externally-threaded shielding barrel or well

13 of a spark plug and to a similarly externally-threaded cylinder, or well, or socket 14 associated with the manifold (not shown) in which the various spark plug conductors are contained. By means of the nuts 12, a mechanically secure connection to the parts 13 and 14 may be made, and, moreover, in co-action with other parts later described, dependable sealed junctions can be effected—all while achieving, also, a desirable quick detachability of the lead and terminal structural unit.

Extending within the conduit 10, and suitably insulated therefrom, is a conductor 16, which is preferably flexible and, hence, may be a stranded conductor; by way of the conductor 16, the high potential energy required to energize the spark plug is to be conveyed, and to insulate the conductor 16 from the radio-shielding metal parts of the conduit 10 I prefer to employ an insulating covering 17 about the wire 16, and this insulation 17 may be of any desired or suitable construction or composition, or of combinations of insulating compositions or elements, preferably adequate to dependably insulate the wire 16 for the voltage of the energy it is to carry, with usual or appropriate margins of safety. The wire 16 extends preferably coaxially of the conduit 10, which contains a suitable insulating compound 18 which can, if desired, be of a dielectric strength such as to provide for the adequate insulation of the wire 16 from the conduit 10 independently of the insulating covering or sheath 17 which, in such case, need not be employed, if desired, in so far as certain features of my invention are concerned. The compound 18 may be of any desired composition or material, preferably relatively flexible, and where the insulation 17 about the wire 16 is omitted, the consistency of compound 18 is preferably such as to coact in maintaining the conductor substantially coaxially within the conduit 10, or any other known means may be employed to maintain substantial coaxial relation.

With the insulating sleeve 17 about the wire 16, however, many advantages are achieved; for example, precise coaxial relation need not be provided for; the compound 18 can, desirably, be of more advantagequs consistencies, preferably relatively soft or flowable, and thus better achieve, particularly when under compression, a more efficient and more reliable filling of all of the space within the conduit 10 and about the insulated conductor 16—17, and thus better guard against corona effects and against possible dielectric breakdown.

Any suitable means may be employed to inject the insulating compound 18 into the space between the conductor and the internal walls of the conduit, as by injecting a suitable quantity thereof upon completion of the assemblage of the ferrules and nuts to the conduit 10, and, by means of the nuts, suitable connection may be made to any suitable apparatus for injecting the material 18.

Having injected a suitable quantity of the compound 18 into the space between the conductor and the conduit walls, the compound 18 being in suitable plastic condition and being, illustratively, made up of any suitable uncured rubber-like material, such as natural rubber, any of the synthetic rubbers, or the like, each suitably compounded, such of the compound 18 as projects beyond the outer ends of the ferrules 11 is removed or cleaned off, so as to leave the end boundary of the material 18 substantially along

a plane indicated at 19—all substantially as indicated in Fig. 1—the filler compound 18 being preferably compounded, in known manner, as by adding suitable ingredients or fillers thereto, so that, upon the application of heat to cure it, it swells or expands in substantial or appropriate extent and so that, upon completion of the cure, it is preferably not hard or rigid, but has sufficient softness to be adequately flexible so as to bend with the bending of the conduit 10, as may be necessary.

Since the steps of my method and structural features according to my invention may be employed to construct the insulating terminal at each end of the conduit 10, it will suffice to describe in detail the steps and apparatus, and the parts employed, with respect to one end of the conduit 10. The conductor 16, as shown in Fig. 1, projects beyond the end of the conduit 10 throughout a length commensurate with the length of the insulated terminal structure to be employed, and, where the conductor 16 has an insulating jacket 17 thereabout, the jacket 17 is stripped from the extreme end portion of the ductor 16, thus to bare enough of the wire 16 to permit the application and connection thereto of any desired form of contact or terminal.

Onto the projecting length of conductor I now sleeve an insulating bushing or sleeve, generally indicated by the reference character 21; the sleeve 21 is to coact with the nut 12 and ferrule 11 to achieve a sealed junction with the spark plug well, or manifold cylindrical housing 13 or 14 of Fig. 4, and, hence, is provided with an outwardly-projecting, annular sleeve, flange, or shoulder 21^a which lies against the end face 11^c of the ferrule shoulder 11^b, by which it is tightly seated and compressed against the part 13 or 14 (Fig. 4) when the nut 12 is screwed home, the annular shoulder 21^a thus serving as a gasket. Bushing 21 is, therefore, preferably made of a relatively hard and tough, though still resilient, material and, illustratives, may be made of any suitable rubber-like material, such as natural rubber, synthetic rubber, or the like, compounded in known manner to give the desired hardness with the desired resiliency when subjected to an appropriate cure, usually by heat treatment, and the bushing or terminal insulator 21 is preferably premolded and cured, in any suitable way, before it is sleeved onto the conductor and brought into interrelation with the ferrule 11.

The ferrule 11 and the terminal insulator 21 are shaped to provide coacting engaging surfaces which are proportioned to present large and rapidly increasing areas of contact for a given rate of movement of plastic material radially thereabout, in comparison to the substantially fixed relationship of areas of contact between the bore 21^b of the terminal insulator 21 and the surface of the conductor structure 16—17 within the bore, for the same rate of movement of the same plastic material therealong. For example, the engaging surfaces of the ferrule 11 and of the insulator 21 that lead to the gasket flange 21^a are made of progressively increasing radius, so that the areas thereof increase at a greater rate than does the radius along which the flow of plastic material, tending to escape from within the conduit 10, tends to move, the area increasing with the square of the radius. This relationship can be achieved in any suitable way, illustratively, by internally stepping the ferrule 11 and externally stepping the insulating bushing 21, as shown in Figs. 1 and 2. Thus, for ex-

ample, from the annular face 11c of the ferrule shoulder 11b, surface 11c presenting a rapidly increasing area with increase in radius, I may provide a surface 11d joined to the surface 11e of the shoulder 11f which forms the annular seat within which to receive the ends of the conduit parts 10a and 10b, in turn joined by the external face 11g of the shoulder 11f. One or more of the faces 11d, 11e, and 11g may be frusto-conical, and, by way of illustration, face 11d is so shown; surface 11g may be cylindrical and surface 11e, if not frusto-conical, may lie in a plane at right angles to the axis of the ferrule. In making up the insulating sleeve or bushing 21, it is provided with surfaces 21c, 21d, 21e, and 21f which are dimensioned and shaped snugly to interfit with the surfaces 11c, 11d, 11e, and 11g, respectively, of the ferrule 11, when the sleeve 21 is sleeved onto the conductor 16—17 and seated in the ferrule 11, as shown in Fig. 2.

The radius of the bore 21b substantially matches the radius of the conductor structure 16—17, provision being made for sufficient clearness to make for ease of sleeving of the insulator 21 onto the conductor structure, and the latter and the bore 21b thus provide engaging or juxtaposed cylindrical surfaces of substantially the same radius.

The extreme inner end portion of the insulator 21, with its end face 21g, is thus exposed to the insulating compound 18 that fills the space between the conductor and the conduit 10, the end face 21g engaging and abutting against the end face of the uncured and plastic filler compound 18, as along the line or plane 19, indicated in Fig. 1.

With the parts thus far assembled, I encase the cured and premolded insulator 21 in a mold M, which is preferably a sectional mold, illustratively, of two sections M^1 and M^2, the sections being provided with companion mold cavities 22—22 shaped so as to snugly accommodate and envelop not only the insulator 21, but also the shoulder 11b of the ferrule 11, the nut 12 being sleeved away from the ferrule so as not to interfere with the engagement of the mold sections about the ferrule shoulder or flange 11b. Any suitable means, such as dowel pins and holes, indicated at 23, may be employed to coact with the ferrule shoulder to align the mold sections as they are assembled about the ferrule part and the insulator 21 and brought together into the position shown in Fig. 3, whence the mold sections are secured together by any suitable clamping means (not shown), and, with the other end of the shielded conductor structure likewise fitted with a cured, premolded insulator 21 and a sectional mold M, the complete entity is ready to be subjected to treatment to cure the filler compound 18 and to effect union thereof with the material of the insulator 21.

During the heat treatment to effect cure or vulcanization, the compound 18 swells or expands and, hence, is under compression or hydraulic pressure throughout its entire mass, thus compacting itself tightly and snugly against and about the conductor and also against the interior surfaces of the conduit 10; the hydraulic forces or pressures within the material 18 are, however, also exerted against the end face of each of the terminal insulators 21, but the latter are tightly held against their respective ferrules 11 by the molds M, the mold cavities of which are preferably so proportioned, particularly in those portions that accommodate the gasket flange 21a

(Fig. 2) as in effect to wedge the flange 21a against the ferrule face 11c, but tightness, even at such places, is either difficult to achieve uniformly as successive shielded conductor structures are made or cannot be relied upon to prevent seepage or flow of the plastic compound 18 under the substantial pressures which it exerts during curing. Should any leakage or seepage take place, the material 18, in whole or in part, envelops the gasket flange 21c, and may even be forced further onto and along other external faces of the terminal insulator 21. Were such leakage allowed to take place—and it has been impossible, according to prior practices, to prevent it—the final structure is defective and becomes a reject, because, in curing the compound 18 to the desired extent, that is, to the desired softness, yieldability, or resiliency, those portions of the compound that have leaked onto the gasket flange 21c become united to it during the cure and the flange 21c, of relatively hard or tough consistency with such resiliency as is intended for good gasket connection, has its sealing or gasket action modified, usually erratically or irregularly, by the soft compound from the filler 18 that becomes united to its external surfaces.

According to my invention, however, material of the compound or filler 18 is precluded from reaching the gasket flange to detrimentally affect its sealing action, as above described, because of the relationships of the surfaces of the terminal insulator with respect to those of the ferrule and with respect to the possible paths along which the pressure of the filler material 18 tends to force or flow the compound. Thus, considering Fig. 2, the fluid or plastic compound 18, under the pressure that it exerts, enters the narrow space between the bore 21b and the surface of the conductor 16—17, and commences entry into whatever available space exists between the annular surfaces 11g and 21f, both portions or streams being under the same pressure. That portion that is forced along the bore 21b meets with substantially uniform resistance, for the surfaces which it contacts (the bore 21b and the conductor snugly fitted therein) present the same areas for each increment of movement of plastic material therealong.

But the portion of plastic material that enters between the contacting surfaces of the ferrule 11 and the insulator 21, meets with far greater resistance, because each increment of movement along the path which it has to take to reach the external surface of the gasket flange 21a, meets with progressively increasing areas of opposed or contacting surfaces of the two parts, since the radius progressively increases along the stepped or zigzagged surfaces above described. Along this path, therefore, flow or movement is slower by far than along the path provided between the bore and the conductor, for a given quantity has to be spread over far greater contacting surface areas than is the case with the same quantity entering the bore. Moreover, the clamping or wedging action of the split mold M can, in effect, clamp these opposed and coacting surfaces tightly together, such as surfaces 11e and 21e—an action that may be enhanced where co-acting surfaces are also frusto-conical—and holds them against material separation during heat treatment.

As a result of these relative coactions, the compound of the filler material 18 is prevented from reaching the gasket flange 21a and from affecting its gasketing action, for the lesser resistance along

the path between the bore surface and the conductor permits more ready flow therealong, and the path along the bore functions in effect as a relief chamber or reservoir to receive material of the filler compound 18 that is forced out of the conduit 10, receiving it in sufficient measure so that, aided by the increasing resistance and surface areas provided by the other path, the softer compound does not reach any surface of the gasket flange 21c.

Upon completion of cure, the relatively hard terminal insulator 21 and the relatively soft filler 18 are securely united to each other at the places where they have been brought into engagement, and the compound 18 becomes also united to the insulating jacket 17, where one is employed, and is of a material such as those mentioned above that can be united together by vulcanization.

Upon completion of the cure, it being noted that any suitable form of contact terminal 25 may be assembled in any suitable way to the end of each conductor 16 and terminal insulator 21 before the mold sections are assembled thereto, the mold sections are removed, and the completed structure is ready for installation in the manner above described, and as is better shown in Fig. 4, where the nuts 12 are shown threaded onto the casing or well parts 13—14 to compress the gasket flanges 21a securely in sealing relation between the ferrules and the parts 13 and 14, respectively. In such sealing relation and action, it is only the cured material of the terminal insulators 21, specifically appointed, as above mentioned, for gasketing action, that effects the desired sealed relationships; the sealing flange in each case has a uniform sealing action, being unaffected or uncontaminated by the soft, cured filler 18, the characteristics of which are appropriate for coaction between the conduit and conductor and other parts, but are not appropriate to take part in a gasketing or sealing action. Were the sealing flange to be contaminated, in while or in part, as by leakage above mentioned, dependability or permanency of seal would not be achieved and, instead, rapid failure would result at the point or points of contamination, it being understood that the sealed connection sometimes has to withstand substantial pressures, such, for example, as could be caused by leakage of high-pressure gases from the engine cylinder through the spark plug connection thereto.

As above indicated, the filler 18 and the material of the terminal insulator 21 may be compounded out of any suitable insulating materials and ingredients, all for the purposes above described. Illustratively, and preferably, neoprene is employed for both, the compounding thereof being suitably or appropriately varied according to the respective characteristics desired for the filler 18 and terminal insulators 21. Whatever materials are employed, such as those earlier above mentioned, the respective compounding thereof for the filler 18 and for the terminal insulators 21 may be effected, in any known manner, to give the filler 18, when cured, a Shore durometer reading on the order of 15 and a Shore durometer reading for the material of the insulators 21, when cured, on the order of 65. Where substantial swelling of the filler 18 during cure is desired, suitable ingredients are added in the compounding thereof to cause materially greater swelling thereof during heat treatment than it might normally have, and also some control of the factor of swell may be effected by correspondingly controlling the extent and character of

mechanical working of the compound, as on mill rolls. Additions, during mechanical working, of oils, such as on oil of petroleum base, or of other suitable oleaginous substances which become well and highly dispersed throughout the material, may also be employed to materially increase the swelling characteristics, and, when employed, they have the additional advantage of plasticizing the compound and acting as a lubricant, to facilitate injection of the filler 18 into the space between the conductor and the internal walls of the conduit; in such case the rubber-like base material employed is preferably selected from the types that are oil-resistant, of which neoprene is a good illustration. And it will be understood that other fillers and ingredients usually employed in otherwise placticizing and processing rubber or rubber-like materials, and including plasticizing agents, vulcanizing agents, accelerators, retardants, or the like, may and preferably are also employed in respective amounts or proportions to give the desired processing and curing characteristics.

It will thus be seen that there has been provided in this invention a radio-shielded conductor and terminal insulator construction and method of making the same in which the various objects above noted, together with many thoroughly practical advantages, are successfully achieved. The construction is thoroughly dependable and of uniform action, and it will be seen that the method can be reliably carried out in practice with the attainment of consistent results conducive to quantity production.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinabove set forth, or shown in the accompanying drawing, is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a method of preventing contamination of the gasket-forming portion of an external terminal insulator by the vulcanizable insulating compound within the conduit of a radio-shielded lead that has fittings at an end thereof that comprise a ferrule that is in fluid-tight connection with the conduit and that has an annular face against which to receive a gasket, the steps which comprise forming a surface on the ferrule that extends in increasing radius from an internal portion thereof to said annular gasket face, placing a conductor within the conduit with a portion projecting beyond said ferrule, filling the space between the conduit and the conductor with a vulcanizable insulating compound that is compounded to expand upon heat treatment, premolding out of suitable insulating material and curing to the desired hardness and resiliency a terminal insulator with an annular gasket portion to overlie said annular ferrule face and with a surface of increasing radius to mate with said ferrule surface and with a bore to receive said projecting portion of the conductor, sleeving the terminal insulator onto the projecting portion of the conductor and bringing together said surfaces of increasing radius with said gasket portion overlying said annular ferrule face, subjecting the assemblage to heat treatment to cure and expand said insulating compound and join it to said terminal insulator, and during heat treatment holding the parts together to hold said mating surfaces of increasing radius against material sepa-

ration whereby they offer increasing resistance to movement therealong of compound under pressure and thereby prevent compound from reaching said gasket portion of the terminal insulator.

2. In a method of preventing contamination of the gasket-forming portion of an external terminal insulator by the vulcanizable insulating compound within the conduit of a radio-shielded lead that has fittings at an end thereof that comprise a ferrule that is in fluid-tight connection with the conduit and that has an annular face against which to receive a gasket, the steps which comprise forming a surface on the ferrule that extends in increasing radius from an internal portion thereof to said annular gasket face, placing a conductor within the conduit with a portion projecting beyond said ferrule, filling the space between the conduit and the conductor with a vulcanizable insulating compound that is compounded to expand upon heat treatment, sleeving onto the projecting portion of the conductor a premolded terminal insulator that has an annular gasket portion to overlie said annular ferrule face and a surface of increasing radius to mate with said ferrule surface and a bore to receive said projecting portion of the conductor, subjecting the assemblage to heat treatment to cure and expand said insulating compound and join it to said terminal insulator, and during heat treatment effecting material flow of compound under pressure along the bore and about the conductor therein by holding the ferrule and terminal insulator together to cause said mating surfaces to offer, by their increasing radii, increasing resistance to movement therebetween of compound under pressure, thereby preventing compound from reaching said gasket portion of the terminal insulator.

3. In a method of preventing contamination of the gasket-forming portion of an external terminal insulator by the vulcanizable insulating compound within the conduit of a radio-shielded lead that has fittings at an end thereof that comprise a ferrule that is in fluid-tight connection with the conduit and that has an annular face against which to receive a gasket, the steps which comprise forming an annular surface on the ferrule that extends in increasing radius from an internal portion thereof to said annular gasket face, assembling to the ferrule and the conduit a terminal insulator that has an annular gasket portion overlying said annular ferrule face and an annular surface of increasing radius to substantially mate with said ferrule surface and a bore therethrough, a conductor within the conduit and extending through said bore, and a heat-curable insulating compound within the space between the conductor and the conduit, heat treating the assemblage to cure said insulating compound under conditions of internal pressure thereof to cause it to exert pressure against parts confining it, and during heat treatment holding said mating surfaces of increasing radius against material separation to oppose, with increasing resistance and diminishing rate of movement, any flow therealong of compound under pressure whereby the latter is prevented from reaching said gasket portion of the terminal insulator.

4. A radio-shielded lead with terminal gasket-forming insulator comprising a fluid-tight radio-shielding conduit having a ferrule in fluid-tight connection therewith at an end thereof, said ferrule having an annular gasket face and having an annular surface of increasing radius extending from an internal portion thereof to said annular gasket face, a sleeve-like terminal insulator of cured, relatively rigid, insulating material extending from said ferrule and having an annular gasket portion to overlie said annular ferrule face and having a surface of increasing radius mating with said annular surface of said ferrule, a conductor extending within said conduit and through said sleeve-like terminal insulator, and a cured, relatively flexible, insulating compound within said conduit and about the conductor therein and integrally united to the material of said terminal insulator under conditions of pressure of the compound and of interengagement of said annular surfaces to resist such extent of movement of compound during cure along said annular surfaces as would cause it to reach and contaminate said gasket-forming annular portion of the terminal insulator.

5. A radio-shield lead with terminal gasket-forming insulator comprising a fluid-tight radio-shielding conduit having a ferrule in fluid-tight connection therewith at an end thereof, said ferrule having an annular gasket face and having an annular surface of increasing radius extending from an internal portion thereof to said annular gasket face, a sleeve-like terminal insulator of cured, relatively rigid, insulating material extending from said ferrule and having an annular gasket portion to overlie said annular ferrule face and having a surface of increasing radius mating with said annular surface of said ferrule, a conductor extending within said conduit and through said sleeve-like terminal insulator, and a cured, relatively flexible, insulating compound within said conduit and about the conductor therein and integrally united to the material of said terminal insulator under conditions of pressure of the compound and of interengagement of said annular surfaces to resist such extent of movement of compound during cure along said annular surfaces as would cause it to reach and contaminate said gasket-forming annular portion of the terminal insulator, at least a portion of the length of any space between the conductor and the bore of said sleeve-like terminal insulator, from the ferrule end thereof, containing, and being sealed by, cured compound that is forced thereinto under pressure during cure.

6. In a method of preventing contamination of the gasket-forming portion of an external terminal insulator by the vulcanizable insulating compound within the conduit of a radio-shielded lead that has fittings at an end thereof that comprise a ferrule that is in fluid-tight connection with the conduit and that has an annular face against which to receive a gasket, the steps which comprise forming a surface on the ferrule that extends in increasing radius from an internal portion thereof to said annular gasket face, placing a conductor within the conduit with a portion projecting beyond said ferrule, filling the space between the conduit and the conductor with a vulcanizable insulating compound that is compounded to expand upon heat treatment, premolding out of suitable insulating material and curing to the desired hardness and resiliency a terminal insulator with an annular gasket-portion to overlie said annular ferrule face and with a surface of increasing radius to mate with said ferrule surface and with a bore to receive said projecting portion of the conductor, sleeving the terminal insulator onto the projecting portion of the conductor and bringing together

said surfaces of increasing radius with said gasket portion overlying said annular ferrule face, applying a removable mold about the terminal insulator, securing it in relation to the ferrule to cause the mold to press and hold the terminal insulator axially inwardly of the ferrule and thereby hold said mating surfaces of increasing radius against material separation, and

subjecting the assemblage to heat treatment to cure and expand said insulating compound and join it to said terminal insulator, whereby flow along said mating surfaces of compound being cured is limited as to distance of flow against reaching and contaminating the annular gasket portion of said terminal insulator.

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