United States Patent

Anderson

[15] **3,660,592**

[45] **May 2, 1972**

[54] ANTI-CORONA ELECTRICAL CONDUCTOR

[72] Inventor: **Robert W. Anderson,** Burlington, Vt.

[73] Assignee: **Haveg Industries, Inc.,** Wilmington, Del.

[22] Filed: **Feb. 27, 1970**

[21] Appl. No.: **14,988**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 795,399, Jan. 9, 1969, abandoned, which is a continuation-in-part of Ser. No. 587,531, Oct. 18, 1966, abandoned.

[52] **U.S. Cl.** ..... **174/114 R,** 174/36, 174/102 SC, 174/106 SC, 174/107, 174/110 SR, 174/115

[51] **Int. Cl.** **H01b 7/18**

[58] **Field of Search** ..... 174/113 R, 114 R, 32, 36, 102 SC, 174/110 SR, 106 SC, 107, 115

[56] **References Cited**

UNITED STATES PATENTS

3,164,669 1/1965 Grove ..... 174/114 R

3,404,369 10/1968 Meyerhoff ..... 174/114 R

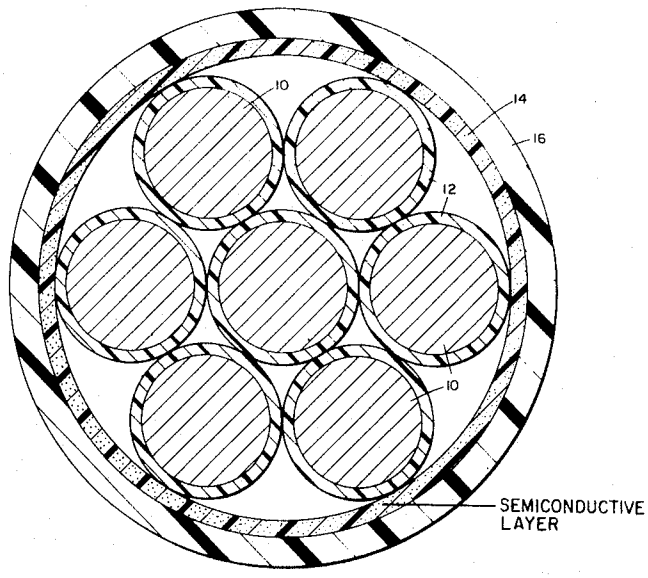
Primary Examiner—E. A. Goldberg

Attorney—Sheldon F. Raizes

[57] **ABSTRACT**

An electrical conductor assembly made up of a plurality of electrical conductor strands connected in electrical parallel each of which is provided with a continuous uninterrupted layer of insulation material. The plurality of the insulated electrical conductor strands are encompassed in an electrical conductive layer which is a fluorocarbon resin having randomly dispersed therein an electrical conductor material such as graphite in discrete particulate form. The graphite is present in amounts of 0.5 to 75 percent based on the weight of the fluorocarbon resin. This electrical conductive layer is floating with respect to ground. Alternatively, the conductive layer is grounded at relatively higher voltages. Surrounding this electrical conductive layer is an insulating support coating.

16 Claims, 10 Drawing Figures



Patented May 2, 1972 3,660,592

4 Sheets-Sheet 1

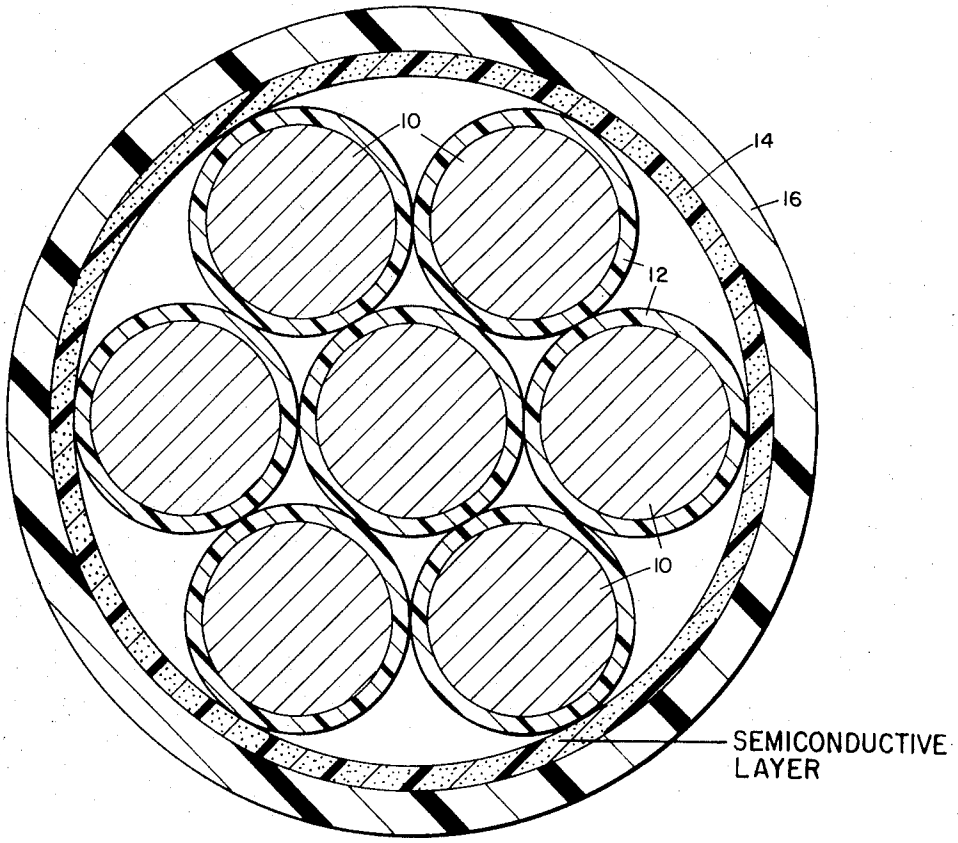


FIG. 1

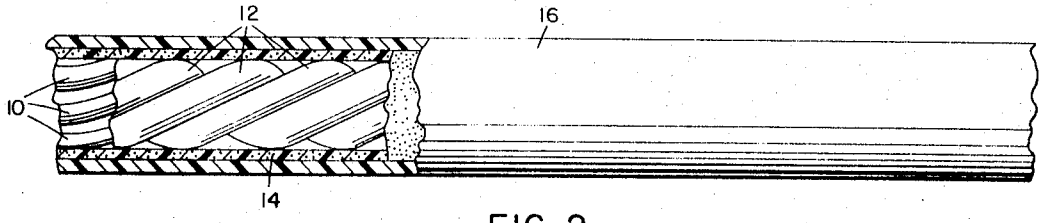


FIG. 2

ROBERT W. ANDERSON
INVENTOR

BY Sheldon L. Razis

ATTORNEY

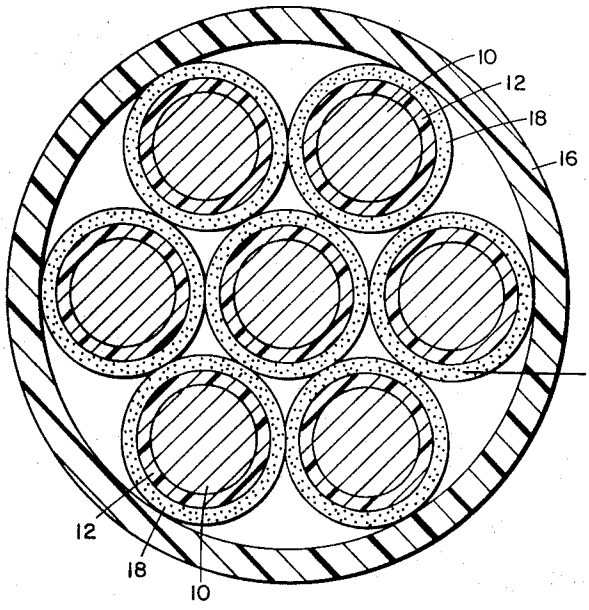


FIG. 3

SEMICONDUCTIVE LAYER

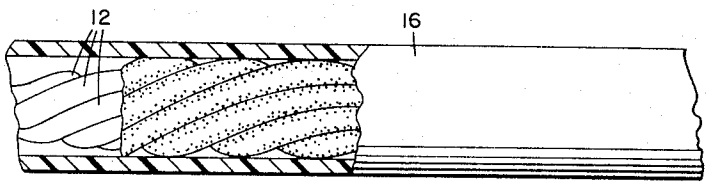


FIG. 4

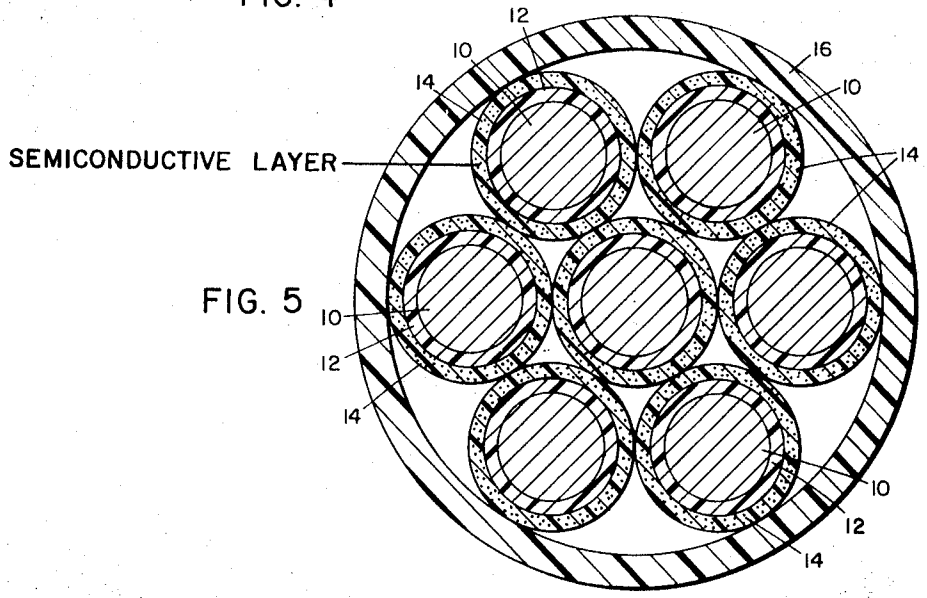


FIG. 5

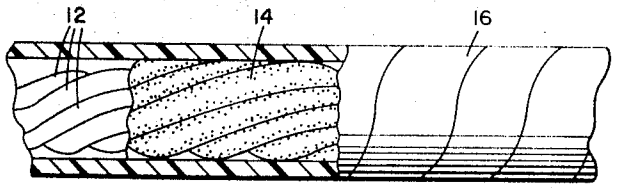


FIG. 6

ROBERT W. ANDERSON
INVENTOR

BY Sheldon F. Rayza

ATTORNEY

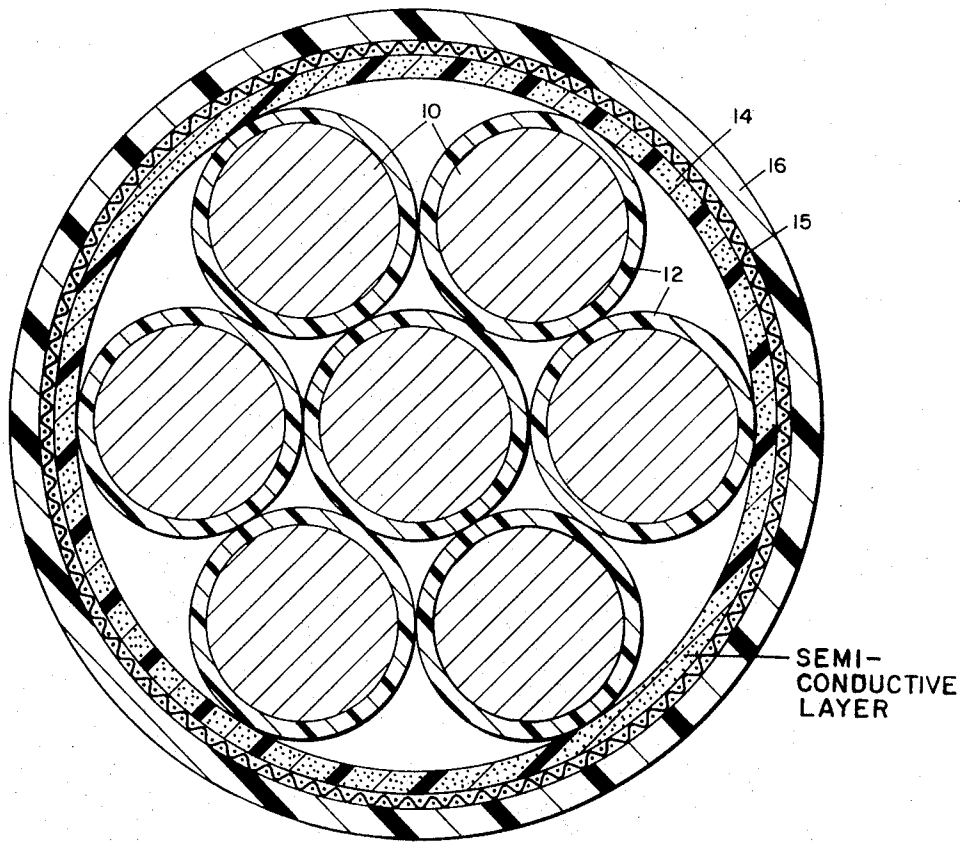


FIG. 7

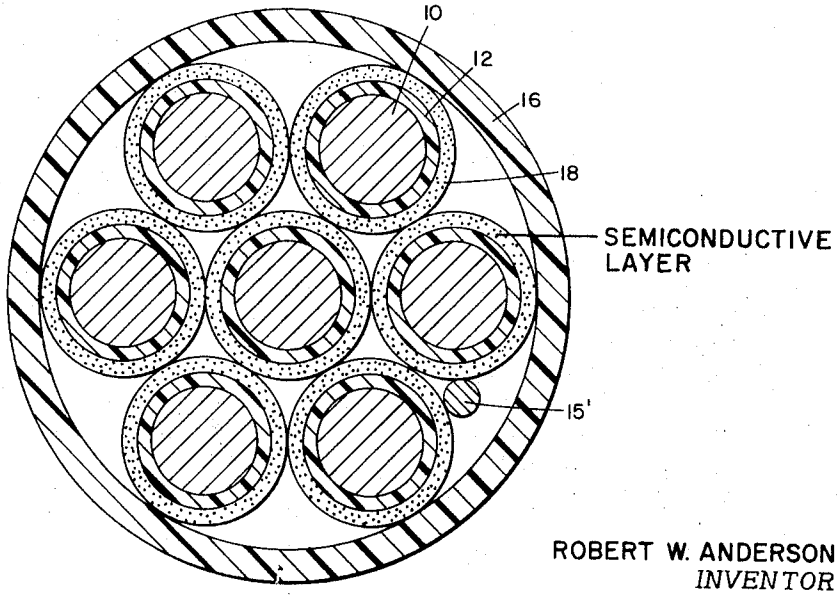


FIG. 8

ROBERT W. ANDERSON
INVENTOR

BY Sheldon F. Rayes
ATTORNEY

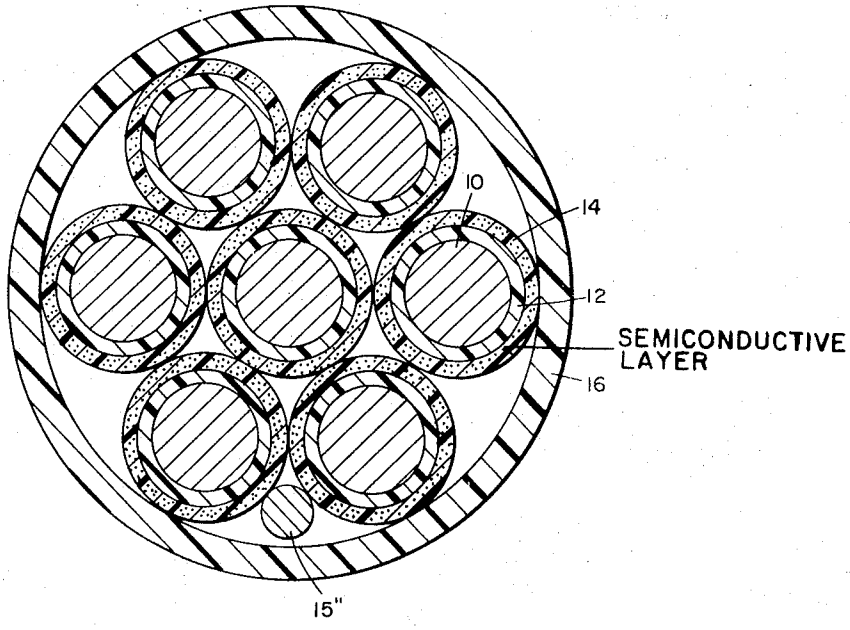


FIG. 9

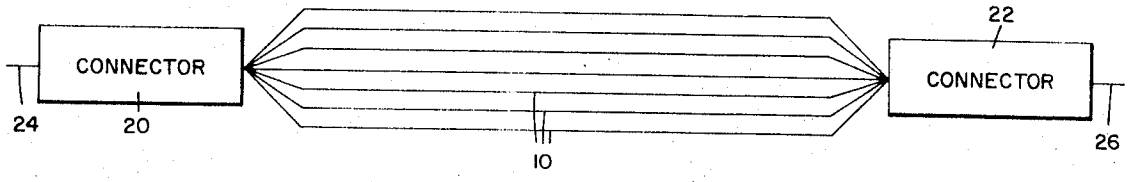


FIG. 10

ROBERT W. ANDERSON
INVENTOR

BY Sheldon F. Rayes
ATTORNEY

ANTI-CORONA ELECTRICAL CONDUCTOR

The present application is a continuation-in-part of my copending application Ser. No. 795,399, filed Jan. 9, 1969, now abandoned, which in turn is a continuation-in-part of application Ser. No. 587,531, filed Oct. 18, 1966, now abandoned.

This invention relates to an electrical conductor and more particularly to an electrical conductor which is resistant to corona breakdown in high voltage applications.

Electrical conductors designed to operate at high voltages often have proved disadvantageous because of corona discharge which has degrading effects upon the insulation covering of the conductor. Generally the factors which contribute to the conductor's tendency to corona include nonuniform density of the dielectric material, excessive porosity or voids in the dielectric, sharp edges of the conductor which can be caused by nicks occasioned when conductors are spliced or stripped and a noncohesive bond between the dielectric covering and the metal conductor.

Efforts, heretofore, to overcome the disadvantages of the corona effect have not proved to be economically satisfactory. For instance it has been found that to insure that any voids which exist in the dielectric will not ionize prohibitively thick insulation coverings were required. Not only are such thick coverings disadvantageous from a cost standpoint, but they add considerable weight and bulk to the conductor thus prohibiting their use in applications where minimum weight and bulk are demanded.

Other efforts have included the provision of an oil impregnated paper as a dielectric, the oil serving to produce void-free insulation. This type of dielectric, however, has serious disadvantages in its manufacture as well as its operation. Such disadvantages include the tendency of the oil to flow especially when the conductor is vertically disposed.

Yet other efforts have been devoted to providing as a dielectric a plurality of layers of a polymeric film having adhered on only one surface thereof a thin electrically conductive continuous metallic film. The dielectric surrounds a plurality of metal strand conductors or single threads of wire which have been twisted into a multiple strand configuration. It will be recognized that the twisting or laying up of the individual metal strand conductors or single threads of wire into a multiple wire strand configuration can cause abrasions or nicks in the metal wires, thus causing peak discharge in the wires, a major contributor to the existence of the corona effect.

It has now been found that the disadvantages of prior art conductors can be overcome by the instant invention which provides an electrical conductor assembly comprising at least one insulated conductor strand surrounded with a layer of a semiconductor material consisting of a graphite containing perfluorocarbon resin with a continuous outer support covering.

The invention will now be more fully described with reference to the accompanying drawings wherein:

FIG. 1 is a radial cross-sectional view of an electrical conductor constructed in accordance with this invention;

FIG. 2 is an elevational view with parts broken away of the same conductor;

FIG. 3 is a radial cross-sectional view of an electrical conductor constructed in accordance with another embodiment of the instant invention;

FIG. 4 is an elevational view with parts broken away of the conductor shown in FIG. 3;

FIG. 5 is a radial cross-sectional view of an electrical conductor constructed in accordance with yet another embodiment of the instant invention;

FIG. 6 is an elevational view with parts broken away of the conductor shown in FIG. 5;

FIG. 7 is a radial cross-sectional view of an electrical conductor constructed in accordance with still another embodiment of the instant invention;

FIG. 8 is a radial cross-sectional view of an electrical conductor constructed in accordance with the conductor illustrated in FIG. 3 wherein a single uninsulated drainwire is included;

FIG. 9 is a radial cross-sectional view of an electrical conductor constructed in accordance with the embodiment illustrated in FIG. 5 wherein an uninsulated drainwire is included; and

FIG. 10 is a diagrammatic view of a conductor constructed in accordance with this invention wherein each of the conductor strands or single threads of wire within the conductor are connected in electrical parallel with each other.

Referring to the drawings, a conductor strand or single thread of wire **10** is provided with an overlying insulation layer **12** which is, preferably a polyimide. The conductor strand **10** can be any electrically conductive wire material such as copper, silver, steel, aluminum, nickel or alloys thereof. Conveniently, the conductive wire has an American Gage wire number ranging, preferably, from about 36 to 0, although it will be recognized that other sizes can be employed depending on the ultimate use of the conductor as well as the degree of flexibility desired. The insulating layer **12** preferably has a thickness of about 6 mils although layers as thin as 0.5 mil and as thick as 15 mils can also be employed. The single conductor strand **10** can be coated with the polyimide by dip coating it with a dispersion or solution of the polyimide and dried. Any number of passes through the polyimide bath can be employed to build up on the conductor an insulating coating of predetermined thickness. Preferably the polyimide can be prepared by reacting at least one organic diamine with at least one tetracarboxylic acid dianhydride. Suitable diamines include meta-phenylenediamine, papa phenylenediamine, 4,4'-diamono-diphenyl propane, 4,4'-diamino-diphenyl methane, benzidien, 4,4'-diamino-diphenyl sulfide, 4,4'-diamino-diphenyl sulfone, 3,3'-diamine-diphenyl sulfone, 4,4'-diamino-diphenyl ether, 1,5-diamino-naphthalene, 3,3'-dimethoxy benzidine, 3,3'-dimethyl-4,4'-diamino-biphenyl, 2,4-bis(beta-amino-t-butyl-phenyl) ether, para-bis(2-methyl-4-amino-pentyl) benzene, para-bis(1,1-dimethyl-5-amino-pentyl) benzene, 1-isopropyl-2,4-methaphenylenediamine, m-xylylenediamine, p-xylylenediamine, bis(para-amino-cyclohexyl) methane, hexamethylenediamine, heptamethylenediamine, octamethylenediamine, nonamethylenediamine, decamethylenediamine, diaminopropyl tetramethylenediamine, 3-methylheptamethylenediamine, 4,4-dimethylheptamethylenediamine, 2,11-diamino-dodecane, 1,2-bis-(3-amino-propxy ethane), 2,2-dimethyl propylenediamine, 3-methoxy-hexamethylenediamine, 2,5-dimethylhexamethylenediamine, 2,5-dimethylheptamethylenediamine, 3-methylheptamethylenediamine, 5-methyl-nonamethylenediamine, 2,17-diamino-eicosadecane, 1,4-diamino-cyclohexane, 1,10-diamino-1,10-dimethyl decane, 1,12-diamino-octadecane, $H_2N(CH_2)_3O(CH_2)_2O(CH_2)_3NH_2$, $H_2N(CH_2)_3S(CH_2)_3NH_2$, $H_2N(CH_2)_3N(CH_3)(CH_2)_3NH_2$, piperazine, 2,6-diamino pyridine, bis(4-amino phenyl) diethylsilane, bis-(4-amino phenyl) phosphine oxide, bis(4-amino phenyl)-N-methylamine, 2,5-diamino-1,3,4-Oxadiazole, 4,4'-diamino-diphenyl diethylsilane, 4,4'-diamino diphenyl ethyl phosphine oxide, 4,4'-diamino diphenyl phenyl phosphine oxide, 4,4'-diamino diphenyl N-methyl amine, 4,4'-diamino diphenyl amine and mixtures thereof.

Representative tetracarboxylic acid dianhydrides include pyromellitic dianhydride, 2,3,6,7-naphthalene tetracarboxylic dianhydride, 3,3'4,4'-diphenyl tetracarboxylic dianhydride, 1,2,5,6-naphthalene tetracarboxylic dianhydride, 2,2',3,3'-diphenyl tetracarboxylic dianhydride, 2,2-bis (3,4-dicarboxyphenyl) propane dianhydride, bis(3,4-dicarboxyphenyl) sulfone dianhydride, 3,4,9,10-perylene tetracarboxylic acid dianhydride, bis(3,4-dicarboxyphenyl) ether dianhydride, 2,2-bis(2,3-dicarboxyphenyl) propane dianhydride, 1,1-bis(2,3-dicarboxyphenyl) ethane dianhydride, 1,1-bis(3,4-dicarboxyphenyl) ethane dianhydride, bis(2,3-dicarboxyphenyl) methane dianhydride, bis(3,4-dicarboxyphenyl) methane dianhydride, ethylene tetracarboxylic dianhydride,

naphthalene-1,2,4,5-tetracarboxylic dianhydride, naphthalene-1,4,5,8-tetracarboxylic dianhydride, decahydronaphthalene-1,4,5,8-tetracarboxylic dianhydride, 4,8-dimethyl-1,2,3,5,6,7-hexahydronaphthalene-1,2,5,6-tetracarboxylic dianhydride, 2,6-dichloronaphthalene-1,4,5,8-tetracarboxylic dianhydride, 2,7-dichloronaphthalene-1,4,5,8-tetracarboxylic dianhydride, 2,3,6,7-tetrachloronaphthalene-1,4,5,8-tetracarboxylic dianhydride, phenanthrene-1,8,9,10-tetracarboxylic dianhydride, cyclopentane-1,2,3,4,-tetracarboxylic dianhydride, pyrrolidine-2,3,4,5-tetracarboxylic dianhydride, pyrazine-2,3,5,6,-tetracarboxylic dianhydride, benzene-1,2,3,4-tetracarboxylic dianhydride, 1,2,3-butane tetracarboxylic dianhydride, thiophene-2,3,4,5-tetracarboxylic dianhydride, 3,4,3′,4′-benzophenone tetracarboxylic dianhydride. Conveniently, the diamine and the tetracarboxylic acid dianhydride are reacted in an organic solvent for at least one of the reactants, preferably under anhydrous conditions for a time and at a temperature below 175° C. sufficient to provide the corresponding polyamide acid. The conductor strand is then passed through the polyamide acid composition and the polyamide acid is converted in situ to a polyimide structure by heating to a temperature above 50° C., preferably between 90° C. to 300° C.

In one embodiment of the instant invention a plurality of polyimide coated conductor strands are provided to produce an electrical conductor assembly. The provision of a polyimide dip coating on each individual wire or strand fills or masks any existing surface irregularities such as nicks, abrasions, upsets or kinks as opposed to a film wrap or layer directly engaging the wire which overlies but does not fill the surface irregularity thereby leaving a space or pocket for ionization or peak discharge. Furthermore, a film insulation at the intersection of the overlapping layers, also leaves pockets for ionization or peak discharge. Any material extruded onto the individual strands or single threads of wire will also fill the surface irregularities and therefore is acceptable as an insulation that is dip coated onto the wire. The polyimide coating of the invention also eliminates metal-to-metal contact when laying up the individual strands or single threads of wire to form the multiple strand conductor thus avoiding nicking, abrading, kinking or any other surface irregularity, which again causes peak discharge, a common factor contributing to corona effect. As can be seen from FIG. 1 the conductor assembly comprises seven polyimide coated strands or single threads of wire of which six are laid up helically around a seventh to form a seven strand conductor. It will also be recognized that if desired another layer of 12 individually polyimide coated strands or wires can be provided as well as a third layer of 18 similarly coated strands or wires laid up about the 12 wire layer. An electrical conductor assembly comprising layers of wires containing a total of 49 strands or wires or even higher, for instance, in the hundreds, can also be provided, if desired.

Superimposed over the polyimide coated conductor is an electrical conductive layer **14** which can be made of any material exhibiting conductivity such as powdered graphite, powdered metal or an electrically conductive plastic. In the case of powdered graphite or metal a carrier therefor is required. The carrier can be any high temperature resistant material compatible with the other components of the conductor assembly and is, preferably a film of fluorocarbon resin. A preferred electrical conductive layer is a film of fluorocarbon resin containing graphite. The film of fluorocarbon resin can, preferably, be a cast film made from an aqueous dispersion of the resin and graphite which is thereafter sintered. For instance, the aqueous dispersion mixture can be cast on a stainless steel belt and the water removed therefrom by air drying to avoid blistering or void formation. Thereafter, the air dried film can be heated to sintering at a temperature, generally up to about 750° F. and the process repeated to build up a film having a predetermined thickness. The exact temperature at which the film is sintered, of course, will depend on the particular fluorocarbon resin chosen, the thickness of the film and the graphite content thereof. Preferably, the graphite containing fluorocarbon resin chosen will have a thickness ranging from 0.25 mils to 10 mils. Also it has been found that the graphite component of the electrical conductive is present in amounts ranging from 0.5 to 75 percent preferably 50 to 60 percent based on the total weight of the film. Representative fluorocarbon resins suitable for the electrical conductive film include tetrafluoroethylene, fluoroethylene propylene, fluorochloro ethylene, trifluoro ethylene, vinylidene fluoride, copolymers of tetrafluoroethylene and hexafluoropropylene (85:15), (60:40), and copolymers of vinylidene fluoride and hexafluoropropylene (15:85), (60:40).

The purpose of the electrical conductive layer **14** is to obviate the possibility of point discharge or peak voltage, thereby reducing the possibility of localized ionization of the air which is the corona effect. All insulations have some leakage. Currents leaking past the insulating layer **12** are ironed out and carried completely around the periphery of the wire by the electrical conductive layer **14** thereby reducing the possibility of point discharge or peak voltage.

The electrical conductive layer **14** is floating with respect to ground. In order to protect the electrical conductive layer **14** against incidental grounding, a conventional support covering or jacket **16** is superimposed over the layer **14**. The jacket **16** can be, for instance, a plastic such as polytetrafluoroethylene, a polyimide as described hereinbefore, a polyester such as polyethylene, terephthalate, a polyolefin, such as polypropylene, polyethylene and polybutylene. Conveniently, the support covering or jacket **16** can be extruded onto the semiconductor surface or it can be applied thereto in other conventional methods such as tape winding and the like.

The instant invention provides an electrical conductor which did not show corona until a much higher voltage was reached than the voltage at which corona was exhibited by a conductor under similar electrical conditions but without the floating electrical conductive layer superimposed over a cable of individually insulated wire strands.

The above embodiment of this invention is suitably employed for a given corona tolerance. However, where a more corona resistant conductor is desired a conductor can be provided in accordance with another embodiment of the invention as shown in FIGS. **3** and **4**. According to this embodiment each strand or wire **10** is dip-coated with a dispersion of solution of the polyimide and dried as outlined hereinbefore, to provide an insulating layer **12**. The polyimide can be also prepared as described above. Thereafter a layer **18** of graphite is applied on the peripheral surface of each strand or wire **10** throughout its length by conveying each strand through a liquid dispersion of graphite. Of course, powdered metal or any other convenient electrical conductive material in discrete particle form can be employed. The dispersing agent can be any conveniently available material. Such dispersing agents include lower alkanol such as isopropyl alcohol. The choice of any particular dispersing agent can be determined by those skilled in the art and will depend, for instance, on such easily recognized factors as the particular polyimide coating applied to each wire or strand. If desired a binder coating can be applied to the graphite layer **18** on the polyimide coated wire. The total amount of graphite or other electrical conductive material used is about 0.5 to 75 percent based on the total weight of the polyimide coating employed. As an alternative to passing each coated strand through a liquid dispersion of graphite, each strand may be covered by an electrical conductive film layer (such as described previously for layer **14**) as shown in FIGS. **5** and **6**.

Thereafter, the individual graphite or electrical conductive material coated insulated wire or strands are arranged in a concentric or unilay manner as is common in the art. The graphite coated wires when so arranged provide electrical conductivity between all surfaces and especially where the wires overlap during the arranging operation. As before an insulating support covering **16** is provided over the assembly of graphite coated, insulated electrical conductors.

In another embodiment of the instant invention, the corona effect can be substantially reduced at terminal connections of the electrical conductor of the instant invention when in effecting a terminal connection, the jacket or support layer and the electrical conductive layer only are stripped and the polyimide coating is dissolved in any suitable organic solvent therefore. In this manner, nicking or abrading the metal conductor is avoided, thus preventing peak discharges when the wires are subsequently connected to, for instance, electrical terminals.

It is to be understood that the electrical conductive layer **14** or **18** does not enter the terminal since, as pointed out above, it remains floating with respect to ground.

The embodiments of the invention hereinbefore discussed have been found to be effective to prevent corona wherein a voltage of approximately 500 to 600 volts has been utilized at atmospheric pressure. However, if the voltage serviced by the conductor assembly is increased over these values, a conductive element must element must be included to act as a drain to be connected to ground.

For example, if a conductor assembly of the configuration illustrated in FIG. **1** is to be utilized for voltages in excess of 500 to 600 volts, a conductive braid or other type of conductive sheath **15** may be included between the layer **14** and the jacket as illustrated in FIG. **7**. Alternatively, a single uninsulated drain wire (not shown) could similarly be placed between the layer **14** and the jacket **16** to accomplish the same purpose as that accomplished by conductive braid **15**.

In the event that the conductor assembly as illustrated in FIG. **3** is to be utilized at voltages in excess of 500 to 600 volts, a single uninsulated drain wire **15'** may be placed in electrical contact with one of the layers **18** as illustrated in FIG. **8**. This drain wire acts, as does the braid **15** in FIG. **7** to ground any excess leakage charge which may be accumulated on any one of the layers **18**. Alternatively, a conductive braid (not shown), similar to that illustrated in FIG. **7**, could be placed at the outer periphery of the conductor to completely encompass all of the conductive strands with the outer jacket **16** being applied over the braid.

In the same way, FIG. **9** illustrates the embodiment shown in FIG. **5** wherein the conductor assembly is to be utilized for voltages in excess of 500 to 600 volts. Here again, a single uninsulated drain wire **15''** is placed into electrical common with the conductive layers **14** so that any excess leakage charge which occurs can be grounded by the drain wire **15''**. Alternatively, a conductive braid (not shown), similar to that illustrated in FIG. **7**, may be placed around the plurality of conductor strands and in contact with the layers **14**, with the outer jacket **16** being applied over the conductive braid.

Still another important feature of this invention is the fact that contrary to multi-conductor cables which have heretofore been known, the conductor assembly herein described provides for a plurality of conductor strands each of which is individually insulated but wherein each of the individual strands or single threads of wire are connected in electrical parallel with respect to one another. In addition to the advantage of preventing abrasions or nicks in the individual conductor strands by the application of insulation over each of the individual strands, the total heating of the conductor assembly may be significantly reduced over that which occurs wherein the plurality of conductor strands **10** are twisted together in electrically and physically contacting relationship and without the presence of insulation over each individual strand. By arranging each individual strand within a separate sheath of insulating material, each strand or single thread of wire will carry the same voltage as each of the other strands but the total current will distribute itself evenly throughout the plurality of strands and in a direct relation to the resistance of each individual strand. For example, if a seven strand cable, wherein each of the seven strands is individually insulated, were connected into a power line of 220 volts AC at a current of **49** amperes, each of the seven individual conductor strands would carry 220 volts AC but only approximately 7 amperes each.

Numerous prior multi-conductor cables are known wherein each of the plurality of conductor strands utilized are individually insulated. However, such separately insulated multi-conductor cables are utilized in such a manner that each of the individual conductor strands are effectively connected to different external electrical circuits in use, and the individual conductor strands are not connected in electrical parallel with one another as is the case in applicant's invention.

A simple diagrammatic illustration of the electrically parallel connection of the individual conductor strands **10** in the conductor assemblies of this invention is illustrated in FIG. **10** wherein the conductor strands are shown electrically coupled between a first connector **20** and a second connector **22**, each of which, in turn, are connected via one or more electrical lines **24** and **26** to an external electrical circuit (not shown). Thus, it can be seen that each of the conductor strands or single threads of wire **10**, while separately insulated from one another, are connected together in electrical parallel so that a common voltage appears thereacross in operation while the current which passes through the conductor assembly is divided up among the individual strands and each of the strands conducts a current significantly less than the total current carried by the conductor assembly.

Obviously, many modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What I claim and desire to protect by letters patent is:

1. An electrical conductor assembly comprising a plurality of electrically conductive single threads of wire in electrical parallel with each other, each of said wires being provided with a continuous uninterrupted layer of insulation material engaging the surface of said wire and filling substantially all surface irregularities of said wire, said plurality of individually insulated conductive wires being encompassed by a layer of electrical conductive material floating with respect to ground and an insulating support coating surrounding said electrical conductive material.

2. The electrical conductor assembly of claim **1** wherein the electrical conductive material comprises a fluorocarbon resin having randomly dispersed therein an electrical conductor in discrete particulate form, said electrical conductor being present in the amounts of 0.5 to 75 percent based on the weight of said fluorocarbon resin.

3. The electrical conductor assembly of claim **2** wherein the fluorocarbon resin is polytetrafluoroethylene and the electrical conductor in discrete particulate form dispersed therein is graphite.

4. The electrical conductor assembly of claim **3** wherein said insulation material is a polyimide.

5. An electrical conductor assembly comprising a plurality of electrically conductive single threads of wire in electrical parallel with each other, each of said wires provided with a continuous uninterrupted layer of insulation material engaging the surface of said wire and filling substantially all surface irregularities of said wire, each of said insulated wire provided with a layer of electrical conductive material floating with respect to ground and an insulating support coating encompassing said plurality of conductive strands.

6. The electrical conductor assembly of claim **5** wherein the electrical conductive material comprises a fluorocarbon resin having randomly dispersed therein an electrical conductor in discrete particulate form, said electrical conductor being present in the amounts of 0.5 to 75 percent based on the weight of said fluorocarbon resin.

7. The electrical conductor assembly of claim **6** wherein the fluorocarbon resin is polytetrafluoroethylene and the electrical conductor in discrete particulate form dispersed therein is graphite.

8. The electrical conductor assembly of claim **7** wherein said insulation material is a polyimide.

9. An electrical conductor assembly comprising a plurality of electrically conductive single threads of wire in electrical parallel with each other, each of said wires being provided with a continuous uninterrupted layer of insulation material engaging the surface of said wire and filling substantially all surface irregularities of said wire, said plurality of individually insulated wires being encompassed by a layer of electrical conductive material, electrical drain means in electrical contact with said layer of electrical conductive material and an insulating support coating encompassing said plurality of insulated wires, said electrical conductive material and said drain means.

10. The electrical conductor assembly of claim 9 wherein the electrical conductive material comprises a fluorocarbon resin having randomly dispersed therein an electrical conductor in discrete particulate form, said electrical conductor being present in the amounts of 0.5 to 75 percent on the weight of said fluorocarbon resin.

11. The electrical conductor assembly of claim 10 wherein the fluorocarbon resin is polytetrafluoroethylene and the electrical conductor in discrete particulate form dispersed therein is graphite.

12. The electrical conductor assembly of claim 11 wherein said insulation material is a polyimide.

13. An electrical conductor assembly comprising a plurality of electrically conductive single threads of wire in electrical parallel with each other, each of said wires provided with a continuous uninterrupted layer of insulation material engaging the surface of said wire and filling substantially all surface irregularities of said wire, each of said individually insulated wires provided with a layer of electrical conductive material, electrical drain means in electrical contact with said layers of electrical conductive material, and an insulating support coating encompassing said plurality of wires and said drain means.

14. The electrical conductor assembly of claim 12 wherein the electrical conductive material comprises a fluorocarbon resin having randomly dispersed therein an electrical conductor in discrete particulate form, said electrical conductor being present in the amounts of 0.5 to 75 percent based on the weight of said fluorocarbon resin.

15. The electrical conductor assembly of claim 13 wherein the fluorocarbon resin is polytetrafluoroethylene and the electrical conductor in discrete particulate form dispersed therein is graphite.

16. The electrical conductor assembly of claim 14 wherein said insulation material is a polyimide.

* * * * *