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Richardson et al.

[11] **3,875,461**

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[54] **STATIC ELIMINATOR**

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[52] **U.S. Cl.** ..... **317/2 F**

[51] **Int. Cl.** **H01t 19/04**

[58] **Field of Search** ..... 317/2 F, 4, 262 A

[56] **References Cited**

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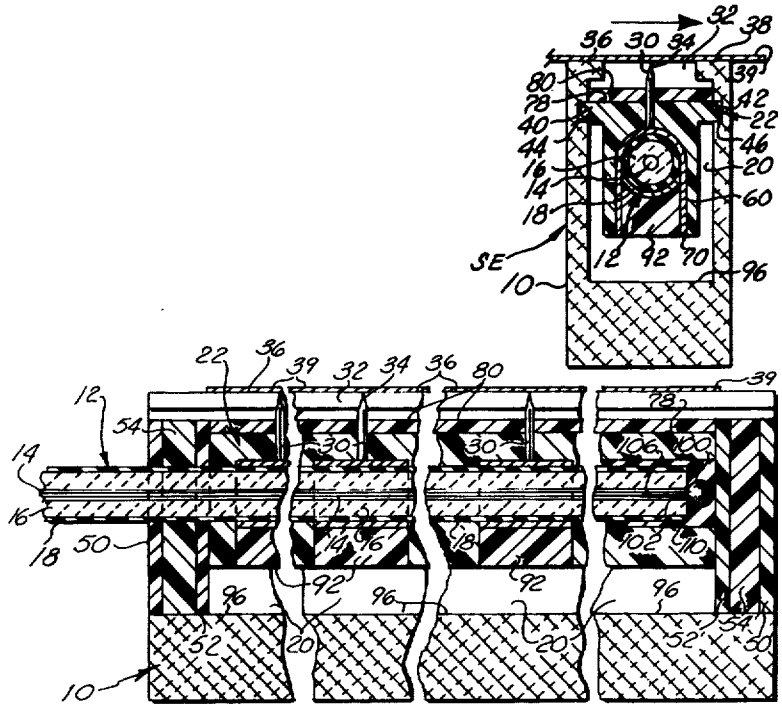
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Primary Examiner—L. T. Hix

[57] **ABSTRACT**

A static eliminator serves to neutralize accumulated electric static charge on a web or sheet material. The static eliminator includes a metal housing having an elongated opening exposing a plurality of corona discharge needles which are longitudinally spaced and mounted to a strip member located within the housing. The strip member is constructed of insulating material, such as plastic, and carries an elongated cable which extends longitudinally within the housing. The cable is the type having a central conductive core surrounded by a layer of dielectric material. The cable is mounted in a groove in the strip member with the groove having spaced apart conductive layers thereon. The corona needles are mounted in the strip at longitudinally spaced locations corresponding with the conductive layers. Each needle is mounted so that it makes electrical contact at one end with an associated conductive layer and extends therefrom so that its opposite end, which is tapered to a point, is exposed in the area of the longitudinal opening in the housing. The cable is terminated within the housing with the terminated end being fitted with a metal corona ball. The ball carries a radially extending electrically conductive projection which, in assembly, is inserted into the exposed end of the cable so as to make electrical and mechanical engagement with the inner electrical core to reduce corona discharge therefrom.

14 Claims, 8 Drawing Figures



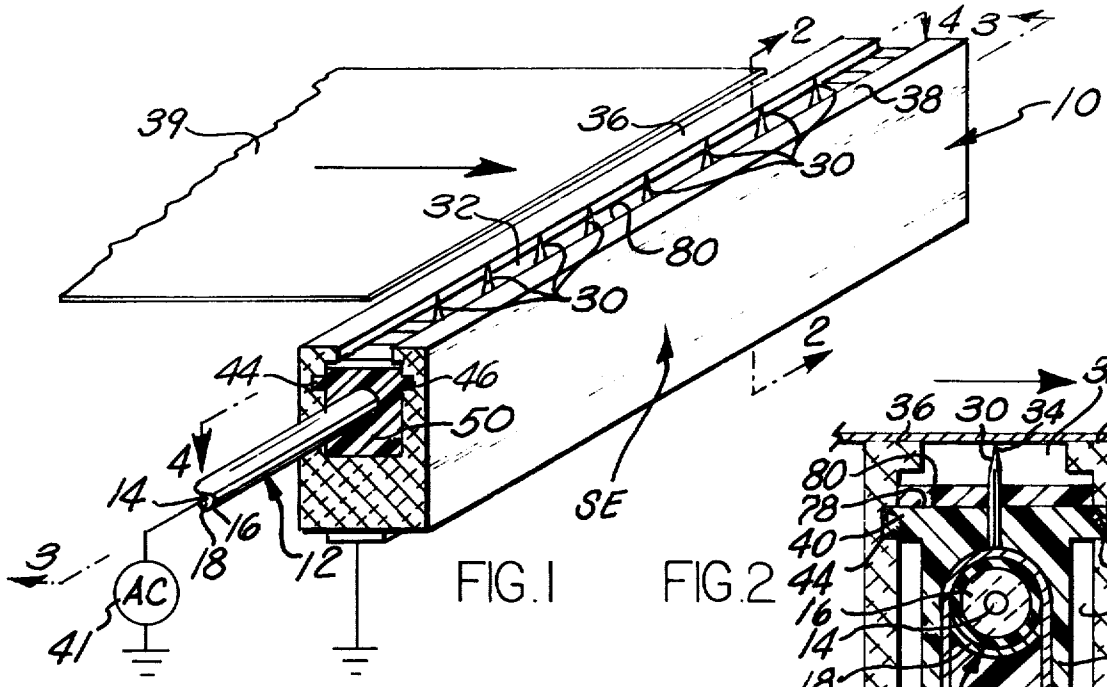


FIG. 1

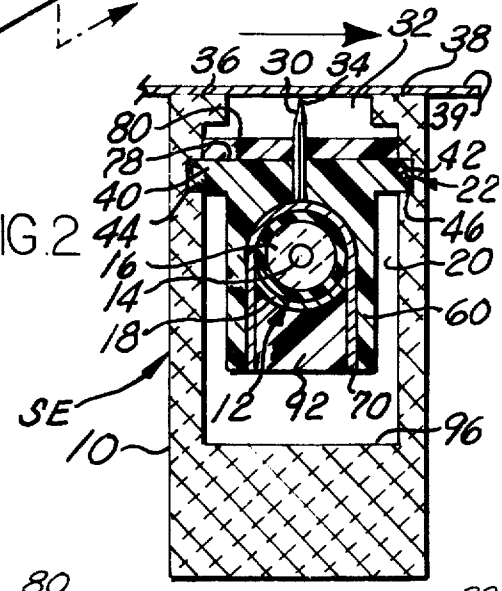


FIG. 2

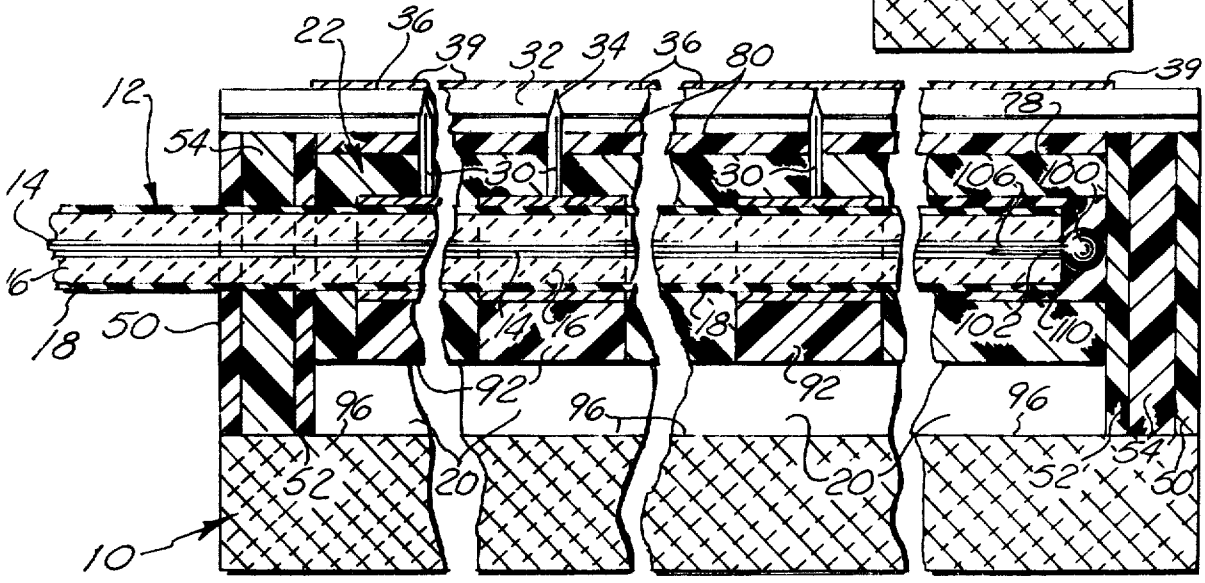
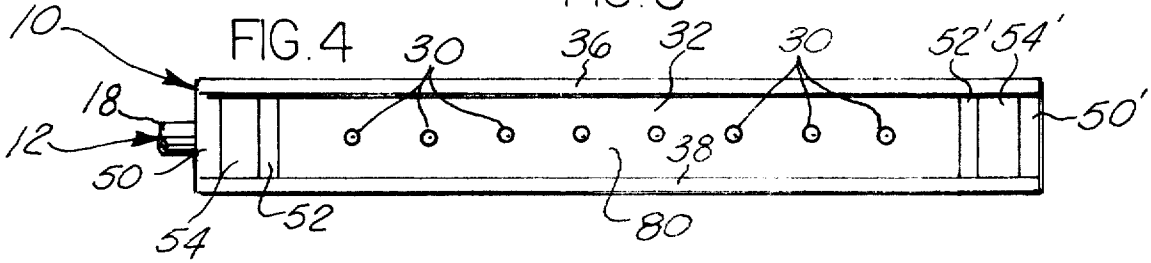


FIG. 3

FIG. 4



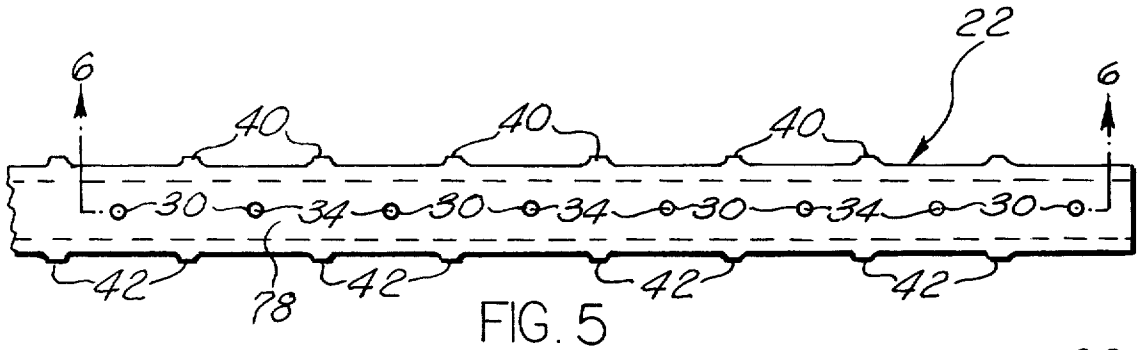


FIG. 5

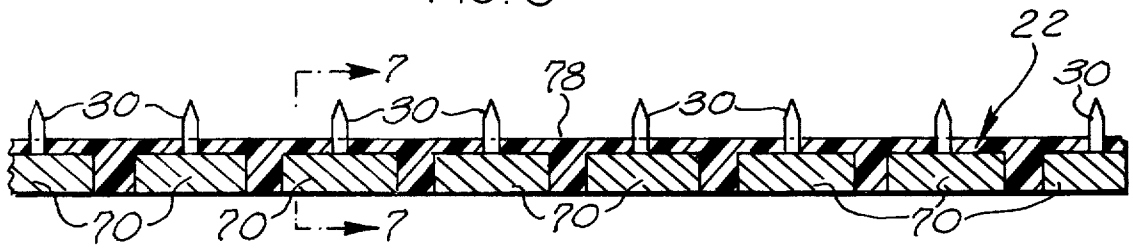


FIG. 6

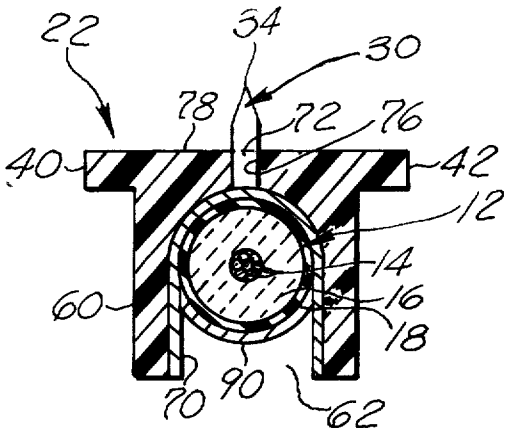


FIG. 7

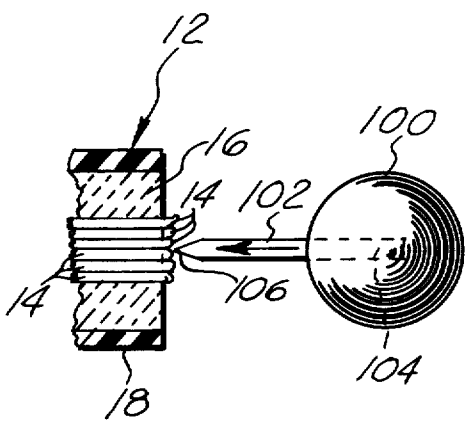


FIG. 8

STATIC ELIMINATOR

This invention relates to the art of static eliminators and more particularly, to an improved static eliminator construction for assisting in removing or neutralizing static electricity accumulated on sheet material, such as paper or cloth, when such material is processed so as to be charged with static electricity.

The invention is particularly applicable for use in conjunction with removing or neutralizing static charge on a web or sheet material processed by xerography or electrophotographic printing and will be described with particular reference thereto; although, it is to be appreciated that the invention may be utilized in various applications requiring the removal of static electric charge from material.

As is known, static eliminators generally comprise an elongated cable having an inner conductive core surrounded by a dielectric layer. A plurality of needlelike projections are electrically connected to respectively associated spaced apart conductive sleeves or plates which are longitudinally spaced apart in close proximity to the cable. This assembly is mounted and electrically insulated from a metallic housing. The housing is connected to an electrical ground. A high voltage AC source, on the order of 7,000 volts, is connected between ground and the inner electrical core. This assembly is positioned so that the needlelike projections extend toward a web or sheet material having an accumulated static charge to be neutralized. The needle points do not make engagement with the web but are slightly spaced therefrom. The high voltage applied to the inner core produces an ionized field about the pointed ends of each needlelike projection and has the effect, when placed in the vicinity of the charged web or sheet, to neutralize the static charge accumulated thereon.

In constructing such eliminators, it is important to prevent short circuits between the various needlelike projections as well as between the projections and the metal housing. It is also desirable to provide a proper capacitance between the inner core and an associated conductive plate. Consequently, tubular electrically conductive plates or sleeves may be carried at spaced locations along the cable with each sleeve having a needlelike projection extending therefrom. However, the structure must be mounted so that the electrically conductive sleeves do not make electrical contact with each other or with the outer electrically conductive housing. This has resulted in fabrication techniques requiring encapsulating a portion of the length of the subassembly with an insulating material so that the tubular sleeves remain spaced from each other, while permitting the projections to be exposed. Frequently, this is a cumbersome and difficult assembly process resulting in close quality control and expense in manufacturing such a static eliminator.

A still further problem existing in the prior art with respect to static eliminators, is the affect of corona discharge from the exposed end of the inner core of the cable. The terminated cable end within the housing presents the exposed end of the inner conductive core. This core may be a plurality of stranded wires which present sharp needlelike projections, resulting in corona discharge. This discharge may be sufficient to destroy the surrounding insulating material and effectively burn a hole through one end of the static eliminator structure. In addition to such destructive affects,

such core end corona discharge adversely affects the corona discharge taking place at the needle projections. This detracts from the efficiency of the static eliminator to neutralize static charge on a web or sheet material.

An object of the present invention provides an improved static eliminator construction which permits easy assembly while achieving electrical isolation between ajacent projection needles.

It is a still further object of the present invention to provide an improved static eliminator wherein corona discharge at the severed or terminated end of the cable within the housing is substantially minimized.

In accordance with one aspect of the present invention, the improved static eliminator construction employs a housing of electrically conductive material and having a longitudinally extending opening to define a longitudinally extending channel within the housing. A nonconductive strip member is mounted to the housing within the channel so as to extend longitudinally therewith. The strip member is provided with a longitudinally extending cable receiving groove. This groove is coated with a layer of electrically conductive material at longitudinally spaced apart locations so that the conductive layers are electrically insulated from each other by the nonconductive material of the strip member. A cable having an inner conductive core surrounded by a layer of dielectric material is received in the groove so that capacitors are effectively defined between coextensive longitudinal portions of the length of the inner core and the associated plurality of spaced apart coatings of conductive material in the groove. A needlelike electrically conductive projection is associated with each of the spaced apart conductive layers and is oriented so as to make electrical connection at one end with the associated conductive layer and extends therefrom through the strip member toward the longitudinal opening in the housing. The plurality of needlelike projections are oriented at longitudinally spaced apart locations corresponding with the plurality of spaced apart conductive layers.

In accordance with another aspect of the present invention, a static eliminator includes an elongated cable having an inner electrically conductive core surrounded by a layer of dielectrical material. Needlelike projections are spaced at longitudinally spaced apart locations along the length of the cable with each needlelike projection being in electrical contact with an electrically conductive layer located proximate to a portion of the length of the cable. The layers of electrically conductive material are longitudinally spaced apart and are electrically insulated from each other. An electrically conductive, metal corona ball is provided with an electrically conductive projection extending therefrom. The ball is mounted to the terminated cable end such that the projection extends into the cable for a portion of the length of the cable and in electrical engagement with the conductive core to thereby minimize corona discharge from the terminated end of the core.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects and advantages of the invention will become more readily apparent from the following description of the preferred embodiment of the invention as taken in conjunction with the ac-

companying drawings which are a part hereof and wherein:

FIG. 1 is a perspective view illustrating the static eliminator in accordance with the present invention;

FIG. 2 is a sectional view taken generally along line 2-2 looking in the direction of the arrows of FIG. 1;

FIG. 3 is a sectional view, with parts broken away, taken generally along line 3—3 in FIG. 1 and FIG. 2 and looking in the direction of the arrows;

FIG. 4 is a plan view taken generally along line 4—4 and looking in the direction of the arrows in FIG. 1;

FIG. 5 is a plan view illustrating the construction of the strip member incorporated in the invention;

FIG. 6 is a sectional view taken generally along line 6—6 in FIG. 5 and looking in the direction of the arrows;

FIG. 7 is a sectional view taken along line 7—7 in FIG. 6 and looking in the direction of the arrows; and,

FIG. 8 is an enlarged fragmentory view illustrating the manner of installing a spherical corona ball to the terminated end of the cable in accordance of the invention.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now to the drawings with the showings are for purposes of illustrating a preferred embodiment of the invention only and not for purposes of limiting same, FIG. 1 is a perspective view illustrating a static eliminator SE constructed in accordance with the invention. The static eliminator, as best viewed in FIGS. 1 and 2, includes an electrically conductive housing **10**, which may be constructed of aluminum, and is generally of rectangular shape in cross section. The housing is somewhat elongated and serves to carry a portion of the length of an insulated cable **12**. Cable **12** is conventional in the art and includes an inner electrical core **14** surrounded by a dielectric layer **16** and an outer insulating layer **18**, which may be constructed of an insulating material such as polyethelene. Housing **10** is provided with a longitudinally extending channel **20**, as shown in FIG. 2, in which there is mounted a longitudinally extending strip member **22**, constructed of electrical insulating material. Strip member **22**, in turn, carries a portion of the length of cable **12** as well as a plurality of needlelike projections **30**. These projections extend upwardly through the strip member **22** and thence into a longitudinally extending opening **32** defined in the upper face of housing **10**.

The pointed end **34** of each needle extends to a point just under the upper surfaces **36** and **38** of housing **10**. These upper surfaces are essentially flat. Sheet material **39**, having an accumulated static charge, is passed over these flat surfaces so as to be located proximate to the pointed ends **34** or projections **30**. The housing **10** is connected to electrical ground and an AC voltage source **41**, on the order of 7,000 volts, is impressed between ground and the inner electrical conductive core **14**. This develops an ionizing field around the projecting point **34** of each needlelike projection **30** for purposes of neutralizing the accumulated electric charge on the sheet material as it is passed over the upper surfaces **36**, **38** of the housing.

The strip member **22**, as best shown in FIGS. **2** and **7**, is generally T-shaped in cross section, having an upper cross bar terminating in outwardly extending ears **40** and **42**. These ears, as best shown in FIG. **5**, are discontinuous and project outwardly at spaced apart locations along the longitudinal length of strip member **22**. If desired, however, the ears **40** and **42** on either side of the strip member may be continuous along the longitudinal side edges of the strip member. The ears are constructed so as to be received in corresponding retainer grooves **44** and **46** located in the inner facing walls of housing **10**. In this manner, the strip member **22** may be assembled for mounting in the housing, as by a sliding fit.

The strip member **22** is not coextensive with the length of housing **10**. Instead, as shown in FIG. **4**, it is somewhat shorter than the length of the housing. The strip member is held in place to prevent longitudinal shifting by means of inserts located in opposite ends of housing **10**. Thus, with reference to FIG. **4**, the left end of housing **10** includes a pair of spaced apart potting dams **50** and **52** of substantially identical shape and having potting material **54** interposed therebetween. Each of the potting dams is of a configuration to essentially fill the cross section of housing channel **20**, as is seen with respect to potting dam **50** in FIG. **1**. During assembly, potting dam **52** is inserted into the channel so as to abut one end of strip member **22**. This potting dam is shaped so as to be snuggly but slidably received in the channel and is constructed of resilient nonconductive rubberlike material. Liquid potting material of nonconductive composition serves as the potting material **54** and is inserted in the space between the open end of housing **10** and the potting dam **52**. Then, potting dam **50** is inserted to close the channel end and hold the liquid potting material **54** in place while it sets. At the opposite end, the inserts include a potting dam **50'**, potting material **54'** and a potting dam **52'**, all constructed and installed in the same manner as discussed hereinabove with respect to potting dams **50** and **52** and potting material **54**.

The strip member **22** is T-shaped, in cross section, and has a downwardly extending leg **60**. This leg is provided with a longitudinally extending cable receiving groove **62** for receiving a portion of the length of cable **12**. Groove **62**, in cross section, resembles an inverted U. The inner walls of this groove are painted at longitudinally spaced apart locations with a conductive layer so as to define a plurality of longitudinally spaced inverted U-shaped conductive layers **70**. Each conductive layer **70** is associated with one of the electrically conductive needle projections **30** (see FIG. **6**). Each needle projection **30**, as best shown in FIGS. **2** and **7**, has a cylindrical base portion **72** and a pointed portion **34**. A suitable aperature **76** is provided in the strip member **22** to receive the base portion **72** of an associated projection **30**. The base portion **72** extends through the aperture to make electrical contact with the electrically conductive layer **70** associated therewith. The pointed end **34** of each needle **30** extends above the upper surface **78** of strip member **22**. During assembly, the upper surface **78** of strip member **22** may be coated with a thin layer of a nonconductive bonding material **80**. However, the thickness of this bonding material is sufficiently thin that the pointed end **34** extends beyond the upper surface of the bonding layer into a free space and terminates just short of a line connecting upper surfaces **36** and **38** of housing **10**.

Once the cable **12** has been mounted in groove **62**, the exposed underside portion of the cable is preferably coated with a layer **90** of electrically conductive paint (see FIG. **7**). This helps to define a tubular, electrically

conductive layer comprised of layers **70** and **90** surrounding core **14** for a portion of its length with the dielectrical layer **16** interposed therebetween to achieve desired capacitive effect. To complete this subassembly, the exposed portion below conductive layer **90** and within the remaining portion of groove **62** may be filled with a suitable bonding material **92** of nonconductive material. It is to be particularly noted from FIG. **2** that the width of leg **60** of the strip member **22** is substantially narrower than the width of channel **20** so that the side walls of the leg do not touch the facing inner walls of the housing. Similarly, it is to be noted that leg **60** terminates short of touching the floor **96** of channel **20** so that a substantial space is interposed between the termination of the leg and the floor of the channel. The spacing between leg **60** and the side walls and floor of housing **20** is not filled with an epoxy or other nonconductive material. Instead, this spacing contains trapped air which has a dielectric constant of 1.0. In operation, this construction of providing a pocket of trapped air has been found to provide a desirable capacitance effect between the painted conductive layers **70** and the outer walls of housing **10** to achieve proper ionization fields at the projections **30** for neutralizing static charge. If the pocket is filled with an epoxy or a nonconductive bonding material, exhibiting a dielectric constant in excess of that of air, this would increase the capacitance between each layer **70** and the outer surface of the housing **10** and thereby disrupt the distributed capacitance in the static eliminator and adversely affect its operation.

During assembly of the static eliminator, a corona discharge ball **100** is installed so as to be mounted flush against the terminated end of cable **12** within the static eliminator housing. As best shown in FIGS. **3** and **8**, cable **12** is terminated so that the conductive core **14** is exposed. This conductive core may be formed of stranded wires and the severed end of each wire may define a sharp point providing a source of corona discharge. If this is permitted, it would adversely affect the operation of the static eliminator by reducing the corona field at each needle projection **30.** Still further, the corona discharge from the ends of such wire strands would tend to burn away the surrounding insulating material and conceivably provide a burn out hold through the static eliminator housing. This effect is minimized to a large extent by employing a silicon base insulating bonding material wherever bonding material is employed in the housing, such as bonding material **92** or **80.** In addition, a corona ball **100** is mounted flush up against the exposed end of cable **12.** Ball **100** may be constructed of electrically conductive material, such as aluminum. The ball carries a projecting pin **102** which extends radially outward therefrom and is secured to the ball, as by a press fit into a radially extending recess **104** or by welding. Preferably, pin **102** is constructed of relatively hard material, such as stainless steel, and is provided with a pointed end **106.** In assembly, the pointed end **106** is forced into the cable so as to engage the core **14** until ball **100** abuts the exposed end of the cable, as is shown in FIG. **3.** Thereafter, a portion of the length of the end of the cable and including ball **100** is encapsulated in an encapsulating cap **110,** which is preferably constructed of an insulating bonding material having a silicon base to resist corona effects. This may be accomplished by inserting the end of the cable together with the ball **100,** mounted thereon, into a thimblelike cup without touching the floor or side walls thereof. The cup is then filled with the bonding material so that it provides electrical insulation, having a thickness of approximately one-sixteenth of an inch. The cup is removed once the bonding material has set to define the encapsulating cap **110.**

Although the invention has been described in conjunction with a preferred embodiment, it is to be appreciated that various modifications and arrangements of parts may be made without departing from the scope of the appended claims.

What is claimed is:

1. A static eliminator comprising:

an elongated hollow metal housing having inwardly facing walls, and a longitudinally extending opening therein to define a longitiudinally extending channel in said housing,

an elongated nonconductive strip member mounted in said housing within said channel and extending longitudinally therein,

a cable having an inner conductive core surrounded by a dielectric layer extending longitudinally of said housing and mounted to said strip member,

said strip member having a longitudinally extending groove for receiving said cable therein,

a plurality of longitudinally spaced apart conductive layers secured to said groove prior to assembly of said cable in said groove in said strip member,

a plurality of needlelike electrically conductive projections each having one end in an electrical engagement with a said conductive layer and extending therefrom through said strip member with said plurality of projections being oriented at longitudinally spaced locations corresponding with said plurality of conductive layers, each said projection having a portion of its length at its opposite end being configured to form a pointed end extending beyond said strip member in the direction toward the opening in said housing

said strip member has a mounting portion and a body portion, said mounting portion being secured to said housing and said body portion having outwardly facing walls spaced inwardly from the inwardly facing walls of said housing to define an air pocket therebetween so as to thereby minimize the dielectric constant between said core and said metal housing.

2. A static eliminator as set forth in claim **1** wherein said longitudinally spaced apart pointed ends extend to a location which is not beyond the longitudinal opening defined in said housing.

3. A static eliminator as set forth in claim **1** wherein said housing has oppositely facing open end walls and said elongated nonconductive strip member located within said housing has its opposite ends spaced inwardly from the opposite open ends of said housing, and electrically nonconductive means disposed within said channel at said opposite ends to fill the space between said open ends and the correspondingly associated ends of said strip member.

4. A static eliminator as set forth in claim **1** wherein said inwardly facing walls extend longitudinally of said housing with the facing side walls thereof having longitudinally extending grooves defined therein, said longitudinally extending strip member having oppositely directed longitudinally extending mounting means at said

mounting portion and being configured so as to be received in said longitudinally extending grooves to mount said strip member to said housing.

5. A static eliminator as set forth in claim 4 wherein said oppositely directed and longitudinally extending mounting means are each defined by a plurality of longitudinally spaced mounting ears adapted to be slidably received in said grooves in said facing side walls of said housing.

6. A static eliminator as set forth in claim 1 wherein said spaced apart conductive layers in said groove are each defined by an electrically conductive coating applied to said groove.

7. A static eliminator as set forth in claim 6, wherein each said coating is painted onto the walls of said groove with a film of electrically conductive paint.

8. A static eliminator as set forth in claim 1 wherein said cable has one end thereof terminated within said housing, an electrically conductive spherical member mounted onto said terminated end so as to abut said terminated end to minimize corona discharge therefrom.

9. A static eliminator as set forth in claim 8 including an electrically conductive projection member extending from said spherical member and extending into a portion of the length of said cable at its terminated end with said projection member being in electrical contact with said inner conductive core in said cable.

10. A static eliminator comprising:

an elongated cable having an inner conductive core surrounded by a dielectric layer, said core adapted to be connected to a high voltage source,

an array of longitudinally spaced electrically conductive needles each having a sharp projection at one end facing in a direction away from said cable,

a like plurality of conductive layers longitudinally aligned and electrically spaced from each other, each said layer being in electrical contact with an associated one of said needles at a point interposed between the projecting end of the associated needle and said elongated cable, each said conductive layer being electrically spaced from said conductive core by said dielectric layer so as to define electrical capacitance between said needle and said core,

said cable having a terminated end,

an electrically conductive spherical member,

an electrically conductive projection extending from said spherical member,

said spherical member being mounted so as to abut the terminated end of said cable with said projection extending into said cable for a portion of its length adjacent said terminated end with said projection making electrical contact with said conductive core whereby said spherical member minimizes corona discharge from the terminated end of said electrical core.

11. A static eliminator as set forth in claim 10, including a nonconductive strip member for mounting said cable, said conductive layers and said needles, said conductive layers being defined by longitudinally spaced apart conductive coatings applied to said strip member.

12. A static eliminator as set forth in claim 10, wherein said strip member has walls defining a longitudinally extending cable receiving groove.

13. A static eliminator as set forth in claim 12, wherein said conductive layers are defined by longitudinally spaced apart conductive coatings applied to the walls defining said cable receiving groove.

14. A static eliminator as set forth in claim 13, wherein each said conductive coating is defined by application of a thin layer of conductive paint to the walls defining said cable receiving groove.

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