

[54] **METHOD OF PACKAGING, SHIPPING AND INSTALLING DISCHARGE ELECTRODES FOR ELECTROSTATIC PRECIPITATORS**[76] Inventor: **Robert H. Dusevoir**, Box 2082,
Dearborn, Mich. 48021[22] Filed: **Apr. 12, 1974**[21] Appl. No.: **460,381****Related U.S. Application Data**

[62] Division of Ser. No. 311,214, Dec. 1, 1972, Pat. No. 3,819,985.

[52] **U.S. Cl.** **29/624; 53/21 FW; 53/118;**
140/80; 140/139; 242/159[51] **Int. Cl.²** **B03C 3/40; B65H 54/04;**
B65H 55/04[58] **Field of Search** 53/117, 118, 21 FW, 32,
53/113, 116; 29/624; 242/159, 164, 165,
128; 140/80, 139, 140, 147; 72/127, 146,
371; 206/328, 330, 388, 389, 398; 313/351,
354; 55/2, 140, 141, 143, 145, 148, 151,
152, 154; 317/3, 262 A; 174/126 R, 131 A,
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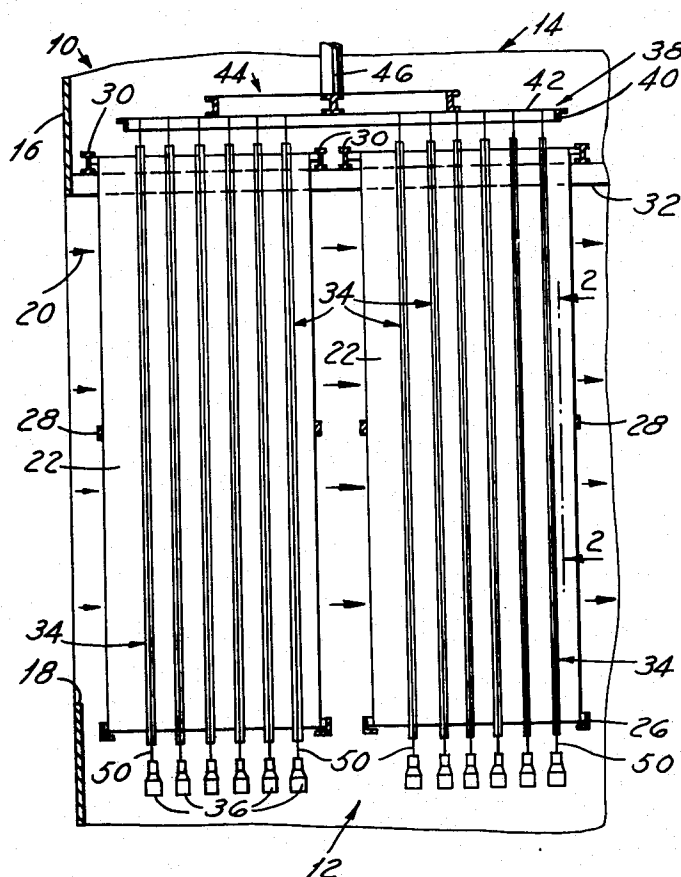
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[57]

ABSTRACT

An electrostatic precipitator discharge electrode having an outer conductive sheath with a generally axially extending inner core therein and an insulator therebetween is coiled so that the outer sheath thereof is plastically deformed with none of the components being fractured and packaged in a container for shipping. After the container is shipped to the job site, the coiled electrode is removed, straightened and cut to the desired length to provide a straight axially extending discharge electrode for installation in an electrostatic precipitator.

10 Claims, 9 Drawing Figures

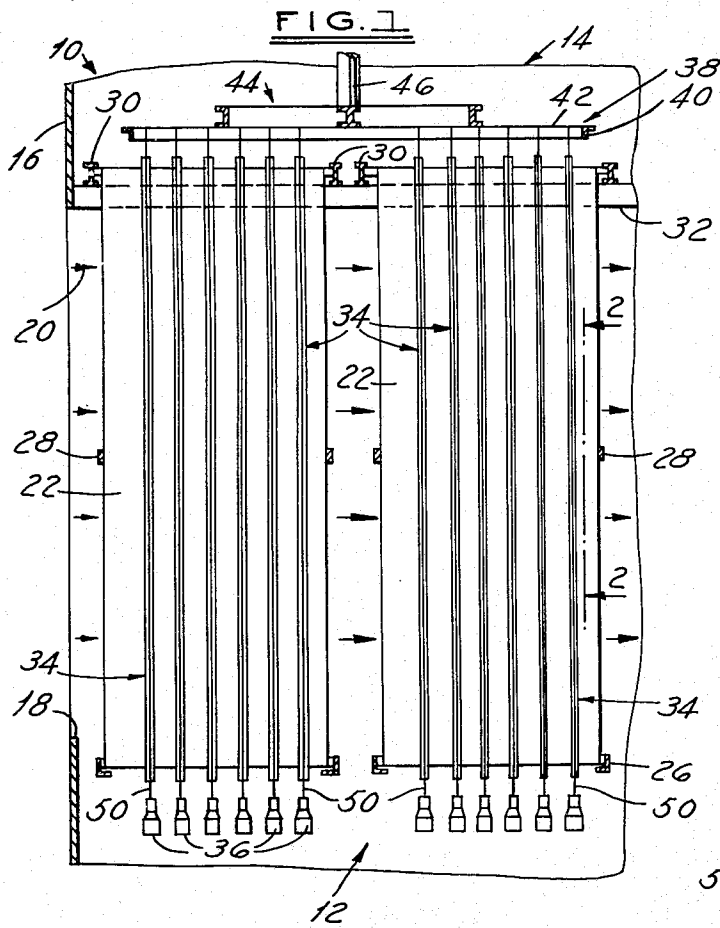


FIG. 2

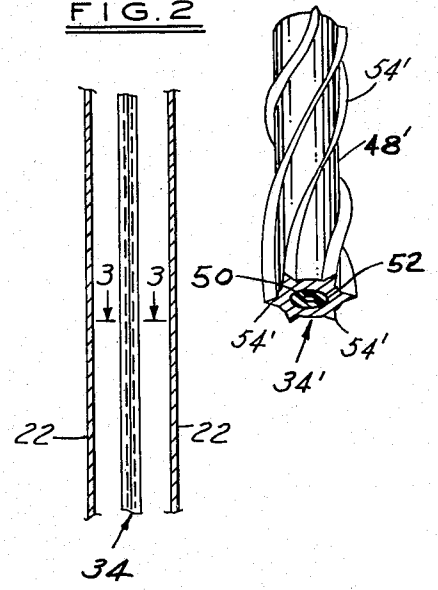


FIG. 4

FIG. 3

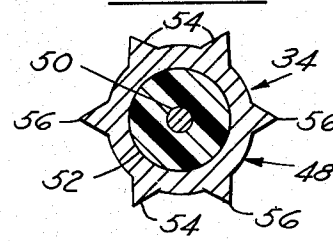


FIG. 5

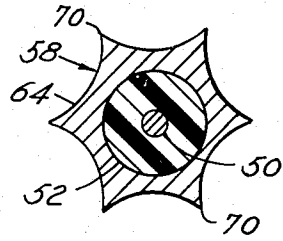


FIG. 6

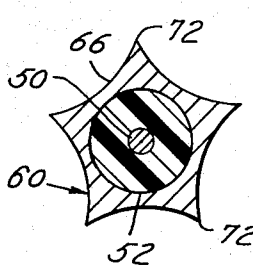


FIG. 8

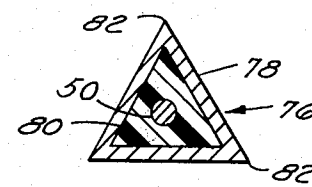


FIG. 7

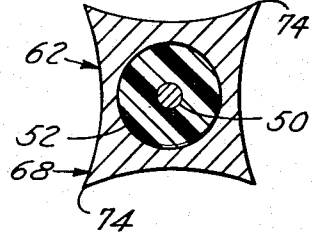
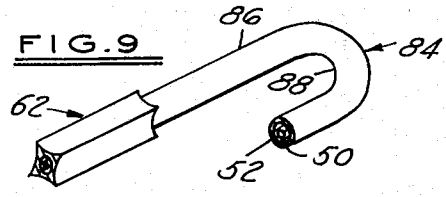


FIG. 9



METHOD OF PACKAGING, SHIPPING AND INSTALLING DISCHARGE ELECTRODES FOR ELECTROSTATIC PRECIPITATORS

CROSS-REFERENCE TO A RELATED APPLICATION

This is a divisional of my copending U.S. Pat. application Ser. No. 311,214 filed on Dec. 1, 1972, entitled "Discharge Electrodes for Electrostatic Precipitators and Method of Shipment and Installation," and now U.S. Pat. No. 3,819,985.

This invention relates to electrostatic dust precipitators and more particularly to methods of packaging, shipping and fabricating at the job site discharged electrodes for electrostatic dust precipitators.

A typical industrial electrostatic dust precipitator has a plurality of interleaved ground and high potential electrodes between which gases such as those produced by combustion with particulate contaminants therein are passed. A high voltage in the order of 40KV is supplied to the electrodes so that the particulate contaminants in the gases passing over the electrodes are deposited on the ground plates. One such precipitator is shown in U.S. Pat. No. 3,633,262, issued Jan. 11, 1972, in which the ground electrodes are flat generally vertically extending plates on the order of 6 feet wide and 27 feet high and the high potential or discharge electrodes are rows of long thin wires extending generally vertically between the ground plates. Typically, these long thin solid wire discharge electrodes have a diameter of approximately 0.100 of an inch and are 25 to 30 feet long. Usually, these solid wire electrodes are crated and shipped as long straight strands so that they are not permanently deformed or bent although some of these electrodes are sufficiently resilient to be shipped in large diameter coils without exceeding the elastic limit of the solid wire electrodes. In use, these long thin solid wire discharge electrodes tend to break and whip about, thereby electrically shorting out and damaging the other electrodes of the precipitator. These solid wire electrodes break due to concentration of the electrical discharge at certain points thereon, arcing, material fatigue, erosion, corrosion, etc.

Objects of this invention are to provide a method of packaging, shipping and fabricating on the job site discharge electrodes which decreases the cost of packaging, handling and shipping the electrodes, decreases the likelihood of damage of electrodes during transit and storage, and eliminates the need for a manufacture of discharge electrodes to maintain an inventory of discharge electrodes of various lengths.

These and other objects, features and advantages of this invention will be apparent from the following description, appended claims and accompanying drawing in which:

FIG. 1 is a fragmentary sectional view of an electrostatic dust precipitator with discharge electrodes embodying this invention.

FIG. 2 is a fragmentary sectional view on line 2—2 of FIG. 1 showing a discharge electrode suspended between two ground electrode plates.

FIG. 3 is a cross sectional view of the discharge electrode on line 3—3 of FIG. 2.

FIG. 4 is a fragmentary perspective view of a modified form of the discharge electrode of FIG. 1 with helical ribs.

FIGS. 5 through 8 are cross sectional views of modified forms of discharge electrodes embodying this invention.

FIG. 9 is a fragmentary perspective view of the discharge electrode of FIG. 7 showing a hook for suspending the electrode in an electrostatic precipitator.

Referring to the drawing, FIGS. 1 and 2 illustrate an electrostatic dust precipitator 10 with a generally rectangular gas chamber 12 having spaced generally parallel side walls 14 (only one of which is shown) and a front wall 16 having an inlet opening 18 therein through which gases with particulate contaminants are forced in the direction of arrows 20 (FIG. 1). A plurality of ground potential electrodes in the form of generally rectangular plates 22 are mounted in chamber 12 by transversely extending lower tie bars 26, intermediate spacer bars 28, and upper tie bars 30. Upper tie bars 30 are carried on members 32 fixed to side walls 14. Tie bars 26 and 30 and spacer bars 28 are pivotally connected to ground electrode plates 22 as shown in the aforesaid U.S. Pat. No. 3,633,262 which is incorporated herein by reference and, hence, will not be explained in greater detail. A plurality of discharge electrodes 34 each with a milkbottle weight 36 fixed to its lower end are suspended between ground electrode plates 22 by a rack 38. Rack 38 has a generally rectangular outer frame 40 with a plurality of bars 42 fixed thereto and extending generally parallel with ground plates 22. Rack 38 is suspended above the ground electrodes by a carrier frame 44 which is electrically connected with a high potential source of current through an electrically conductive connector bar 46.

As shown in FIG. 3, each discharge electrode 34 embodying this invention has an outer sheath 48 of an electrically conductive material such as aluminum, copper or steel and an inner core 50 of a high tensile strength material such as a solid steel wire or rod. An insulator 52 of a dielectric material such as Teflon or nylon is interposed between outer sheath 48 and inner core 50 and retains core 50 generally axially within outer sheath 48 in fixed relation thereto. Insulator 52 can be cast within outer sheath 48 so that it adheres to both the outer sheath and inner core. Preferably, insulator 52 is preformed on inner core 50 and then pulled into outer sheath 48 in firm frictional engagement therewith to retain the insulator and core in the sheath. Preferably, insulator 52 extends the entire longitude of outer sheath 48 and inner core 50 extends at least substantially the length of sheath 48 and can extend beyond the sheath (as shown in FIG. 1) to provide a means for attaching weight 36 to the lower end thereof. To increase the corona current emission of electrode 34, six integral circumferentially spaced ribs 54 on the periphery of outer sheath 48 extend substantially the entire longitude thereof. Ribs 54 have a generally V-shaped cross section and terminate in longitudinally extending radially outwardly projecting apices 56 providing sharp projections on outer sheath 48 which are believed to increase the corona current emission of the electrode and produce a so-called "daisy" corona discharge pattern. Ribs 54 extend in a generally straight line throughout substantially the entire length of outer sheath 48.

FIG. 4 illustrates a discharge electrode 34' with ribs 54' coiled in a helix on outer sheath 48'. Electrode 34' is the same as electrode 34 except for helical ribs 54'. Due to the coiling of ribs 54', they have a greater lineal

length than the axial length of the portion of the outer sheath on which they are coiled. Helical ribs 48' are believed to increase the corona discharge of electrode 34' by increasing the effective area of the ribs.

FIGS. 5 through 8 show electrodes with modified forms of outer sheath cross sectional configurations believed to increase corona current emission and produce a daisy corona discharge pattern. Electrodes 58, 60 and 62 have the same inner core 50 and insulator 52 as electrode 34. Electrodes 58, 60 and 62 have generally star-shaped outer sheaths 64, 66 and 68 with six, five and four points or apices 70, 72 and 74 respectively with generally concave outer surfaces between the points. The electrode 76 of FIG. 8 has an inner core 50 and a triangular shaped outer sheath 78 with a triangular shaped insulator 80 therebetween. Triangular shaped electrode 76 provides three equally spaced sharp points or apices 82 for increasing the corona current emission.

As shown in FIG. 9, a hook 84 can be provided on one end of the electrodes such as electrode 62 to facilitate suspending the electrode in electrostatic precipitators 10. Hook 84 can be provided on electrode 62 by turning down an end portion of outer sheath 62 to remove a portion of ribs 74, thereby providing an integral tubular end portion 86 which is provided with a return bend 88 to make the hook. If desired, another hook can be provided on the other end of the electrode for attaching a weight such as milkbottle weight 36 to the lower end of the electrode.

Materials suitable for making the outer sheath, insulator and inner core of electrodes embodying this invention must perform satisfactorily in the particular operating environment of the precipitator in which the electrodes are used. The gases processed by most precipitators may be corrosive, have abrasive particulate contaminants therein, and are usually at elevated temperatures in the range of 250° to 800°F. Under such conditions, it is desirable to make the outer sheath of corrosion and abrasive resistant materials which remain substantially rigid at these elevated temperatures such as stainless steel, anodized aluminum and nickel steel. Likewise, the particular insulator material must remain in solid form, retain its dielectric properties at these elevated temperatures and not be subject to attack and substantial deterioration by corrosive gases or abrasive particulate contaminants therein over a long period of use. Suitable insulator materials are believed to be Teflon plastic preferably with fiberglass fibers embedded therein, polyvinyl fluoride plastic, pressed asbestos fibers, or other plastic or inorganic insulator materials. The inner core must be made of a suitable material such as high carbon steel wire to retain its tensile strength and should not become substantially corroded or abraded over a long period of use at these elevated temperatures.

To decrease the cost of crating, handling and shipping electrodes embodying this invention to the end user, the long electrodes can be plastically deformed into coils preferably 3 to 6 feet in diameter. The minimum diameter of such coils is dependent on the rupture strength or fracture point of the particular materials used in making the discharge electrodes. Coils 3 feet in diameter are highly satisfactory when the outer sheath is made of so-called half hard aluminum, the insulator of Teflon plastic and the inner core of high carbon steel wire. The coiled electrodes can be straight-

ened at the job site for use in a precipitator with any of the several commercially available tube or wire straightener devices such as the rotary wire straightener sold by the Heppenstall Company, 4620 Hatfield St., Pittsburg, Pa. If desired, the coils can be of sufficient length to provide several electrodes which can be cut to the proper length after straightening at the job site and the hook bent or formed thereon for suspending the electrodes in a precipitator. This method of shipment and installation of the discharged electrodes greatly decreases the cost of providing straight and true discharge electrodes to the ultimate user of a precipitator since the expense for handling, crating and shipping of straight electrodes is often substantially greater than the cost of the electrodes themselves. Moreover, this method of shipment and installation of discharge electrodes substantially decreases the likelihood of damage to the electrodes during transit and storage prior to use. Furthermore, the cutting of the electrodes to the proper length at the job site from long coils eliminates the need for the manufacturer thereof to have a large inventory of discharge electrodes of various lengths.

In use, the outer sheaths of the electrodes embodying this invention tend to develop discontinuities or holes therein due to the concentration of the electrical discharge at certain points thereon, arcing, material fatigue, erosion, corrosion, etc. However, the high tensile strength of inner core 50 and the insulator 52 or 80 prevents the outer sheath from dropping or falling away from the electrodes even if the outer sheath becomes completely severed around its entire periphery so that it is completely separated into two or more portions. Even when the outer sheath becomes completely separated, it usually continues to function effectively in producing a corona current emission throughout its entire length which contributes to the long useful life of this discharge electrode. If the insulator is continuous throughout the longitude of the electrode, it prevents an electrically conductive path from developing through the center core and thus precludes any electrical discharge or arcing involving the center core from occurring and, hence, prevents the center core from being severed. Therefore, even though the outer sheath of the electrode becomes severed in use, the entire electrode does not become severed and, hence, no portion of the electrode breaks away or begins to whip about and short out the other electrodes of the precipitator. Thus, electrodes embodying this invention have a long useful life compared to prior electrodes and do not, when their useful life terminates, short out and damage other electrodes of the precipitator. The outer sheath configurations of these electrodes can be readily extruded of an electrically conductive material such as aluminum and the insulator readily cast or inserted into the outer sheath to securely fix the outer sheath to a high strength inner core such as a commercially available solid steel wire resulting in an electrode assembly having a minimum number of component parts and which is of economical manufacture and assembly.

The outer sheath configuration having a plurality of longitudinally and radially outwardly extending portions terminating in sharp points or apices provides a discharge electrode having a higher corona current emission than conventional wire electrodes. For example, an electrode with an aluminum outer sheath having a cross section shown in FIG. 3 with six longitudinally extending integral outer ribs when positioned in an

electrostatic precipitator having a spacing of 9 inches between the ground plates has a corona current of 16 micro amperes per linear foot compared to 1 micro ampere per linear foot of a conventional medium carbon steel solid wire electrode with a diameter of approximately 0.092 inches at a potential of 30KV on the electrodes of the precipitator and a corona current of 32 micro amperes per linear foot of the conventional wire at a potential of 40KV. The electrode of this example had an aluminum sheath with an inside diameter of 0.18 inches, a steel wire inner core with a diameter of 0.020 inches and a Teflon insulator therebetween. The cross section of the integral ribs of this outer sheath were substantially equilateral triangles having a height of approximately 0.062 inches and the thickness of the wall of the sheath between the ribs was substantially 0.062 inches.

I claim:

1. A method of packaging a discharge electrode comprising, providing a discharge electrode ribbon having an outer tubular sheath of an electrically conductive metal which is rigid and self-supporting throughout an axial length exceeding the desired axial length of a discharge electrode fabricated therefrom and capable of being plastically deformed into a coil without fracturing or rupturing, an inner core extending generally axially through the outer sheath and an insulator of a dielectric material interposed between the outer sheath and the inner core, coiling said discharge electrode ribbon such that the outer sheath thereof is plastically deformed by a cold-working process with none of said outer tubular sheath, inner core, and insulator being fractured or ruptured, and packaging the coiled discharged electrode ribbon in a container.

2. The method of claim 1 wherein said outer tubular sheath of an electrically conductive material is of metal and said discharge electrode ribbon is coiled with a diameter in the range of 3 to 6 feet.

3. The method of claim 1 which also comprises the steps of removing at least a portion of the coiled discharge electrode ribbon from said container, and straightening at least a portion of the coiled discharge electrode ribbon to provide a straight axially extending discharge electrode ribbon portion.

4. The method of claim 3 which also comprises the step of forming adjacent one end of the straight axially extending discharge electrode ribbon portion an integral hook thereon for suspending a straight axially extending discharge electrode in an electrostatic precipitator.

5. The method of claim 3 wherein the discharge electrode ribbon provided for coiling has an overall axial length exceeding a predetermined length of one discharge electrode and the method also comprises the step of severing a part of said straight axially extending

discharge electrode ribbon portion to an axial length equal to said predetermined length to provide a straight axially extending discharge electrode of predetermined length.

6. The method of claim 5 which also comprises the step of forming adjacent one end of the discharge electrode of predetermined length an integral hook thereon for suspending such discharge electrode in an electrostatic precipitator.

7. The method of claim 1 wherein said outer tubular sheath of an electrically conductive material is of metal and said discharge electrode ribbon is coiled with a diameter not greater than 6 feet.

8. The method of claim 7 which also comprises the steps of removing at least a portion of the coiled discharge electrode ribbon from said container, and straightening at least a portion of the coiled discharge electrode ribbon to provide a straight axially extending discharge electrode ribbon portion.

9. The method of claim 8 wherein the discharge electrode ribbon provided for coiling has an overall axial length exceeding a predetermined length of one discharge electrode and the method also comprises the step of severing a part of said straight axially extending discharge electrode ribbon to an axial length equal to said predetermined length to provide a straight axially extending discharge electrode of predetermined length.

10. A method of packaging, transporting and fabricating discharge electrodes comprising, providing at a point remote from a job site a discharge electrode ribbon having an outer tubular sheath of electrically conductive metal which is rigid and self-supporting throughout an axial length exceeding the desired axial length of a discharge electrode to be fabricated therefrom and is capable of being plastically deformed into a coil and subsequently straightened without fracturing or rupturing, the discharge electrode ribbon having an inner core extending generally axially through the outer sheath and an insulator of dielectric material interposed between the outer sheath and the inner core, coiling said discharge electrode ribbon such that the outer sheath thereof is plastically deformed by a cold-working process without said outer tubular sheath, inner core, and insulator being fractured or ruptured, packaging the coiled discharge electrode ribbon in a container, transporting the container with the coiled discharge electrode ribbon therein to the job site, at the job site removing at least a portion of the coiled discharge electrode ribbon from the container, at the job site straightening at least a portion of the coiled discharge ribbon to provide a straight axially extending discharge electrode ribbon portion, and at the job site severing the straightened axially extending discharge electrode ribbon portion to provide a plurality of discharge electrodes of predetermined lengths.

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