

[54] **DISCHARGE ELECTRODE FOR AN ELECTROSTATIC PRECIPITATOR**

[75] Inventor: Pavel Imris, West Haven, Conn.

[73] Assignee: Resource Control, Inc., West Haven, Conn.

[22] Filed: July 22, 1971

[21] Appl. No.: 165,108

3,344,051 9/1967 Latham, Jr. .... 204/327 X  
3,452,225 6/1969 Gourdine ..... 310/11

**FOREIGN PATENTS OR APPLICATIONS**

500,574 1/1951 Belgium ..... 55/150  
11,810 1894 Great Britain ..... 204/320

Primary Examiner—Dennis E. Talbert, Jr.  
Attorney—Curtis, Morris & Safford

[52] U.S. Cl. .... 55/146, 55/150  
[51] Int. Cl. .... B03c 3/41  
[58] Field of Search ..... 55/150, 151, 152,  
55/146, DIG. 38; 204/280, 312, 313, 320, 327

[56] **References Cited**

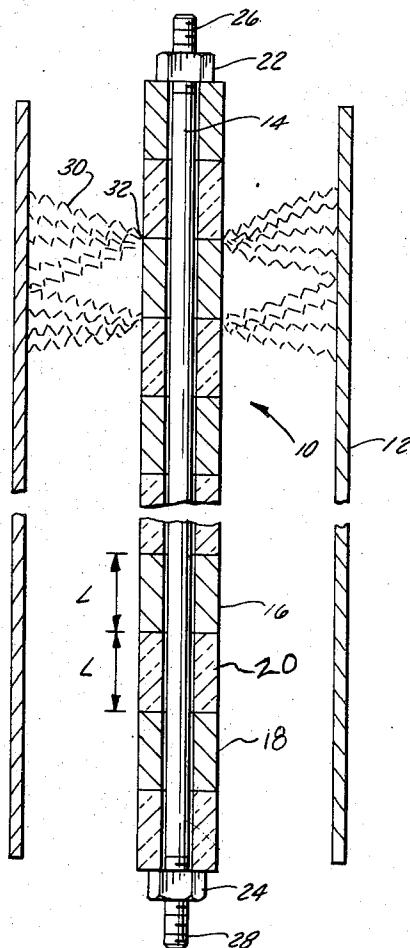
**UNITED STATES PATENTS**

648,764 5/1900 Lamprey ..... 204/313  
1,322,163 11/1919 Conover ..... 55/152  
1,357,202 10/1920 Nesbit ..... 55/152 X  
2,274,636 3/1942 Richardson et al. .... 204/312

[57] **ABSTRACT**

A discharge electrode for use in electrostatic precipitators is provided wherein the surface of the electrode is formed of alternate sections of conductive and non-conductive materials supported on an electrically conductive inner rod. When the electrode is in use, corona formation occurs at the interface between the conductive and nonconductive sections.

**2 Claims, 6 Drawing Figures**



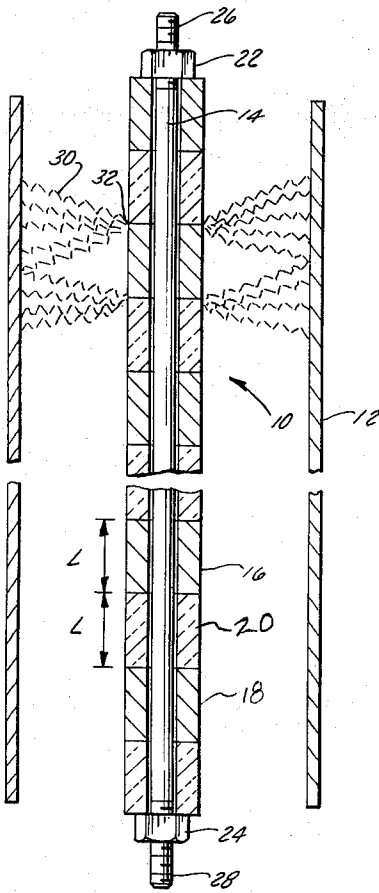


FIG. 1

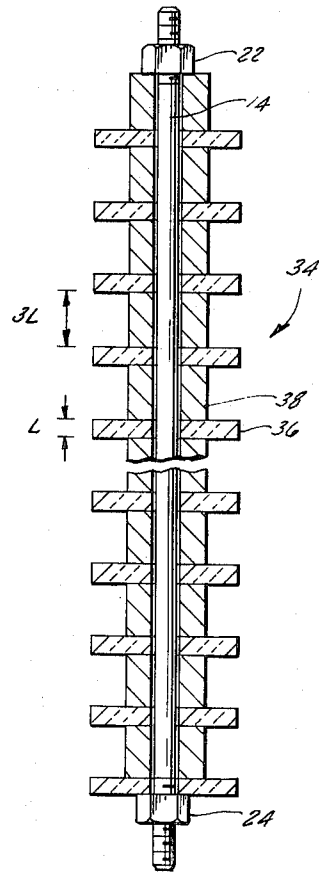


FIG. 2

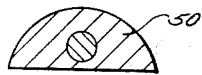


FIG. 4

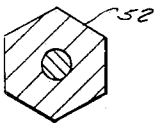


FIG. 5

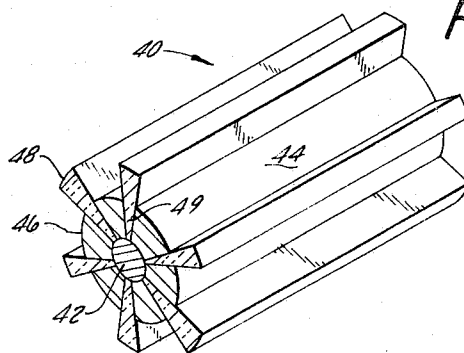


FIG. 3

INVENTOR.

PAVEL IMRIS

BY

*Curtis, Morris & Sifford*

ATTORNEYS

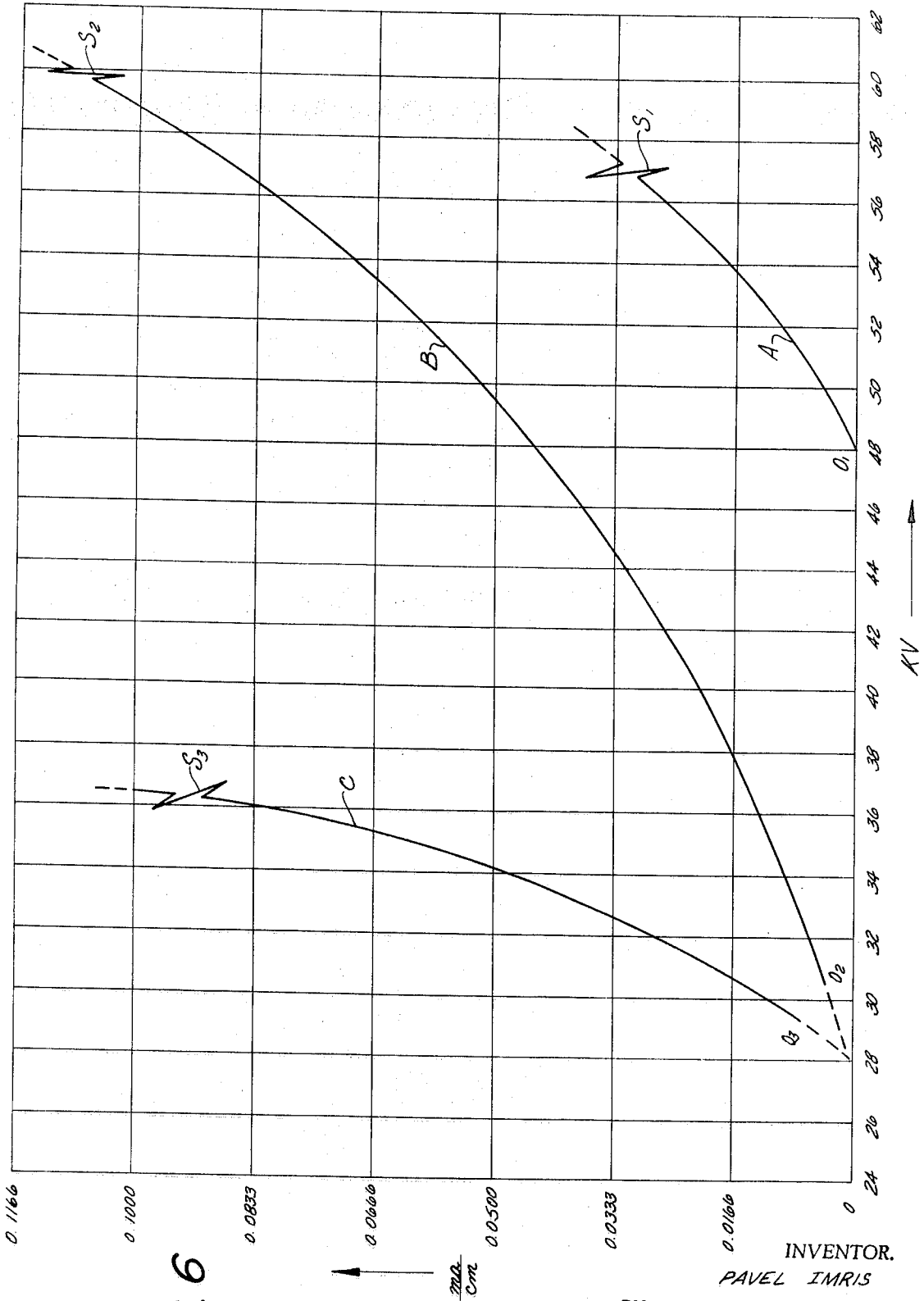


FIG. 6

INVENTOR.  
PAVEL IMRIS  
BY  
*Curtis, Morris & Safford*  
ATTORNEYS

## DISCHARGE ELECTRODE FOR AN ELECTROSTATIC PRECIPITATOR

This invention relates generally to discharge electrodes and, in particular, to discharge electrodes for use in electrostatic precipitators.

Electrostatic precipitators, such as those used in air pollution control equipment, and many other electrical devices, utilize the electric corona phenomena to effectively perform their functions. Such coronas occur when the potential in a conductor increases to a value at which the dielectric strength of the surrounding air or gas is exceeded and the air or gas becomes ionized.

The current-voltage characteristics of corona in electrostatic precipitators or the like are a function of several variables such as:

1. gas composition;
2. gas temperature and pressure;
3. electrode geometry;
4. voltage wave form and polarity; and
5. particle films on the electrodes and particle suspension in the gas.

The present invention is related to the problems involved in electrode geometry and to improvements of electrode geometry for overcoming these problems.

It is well known to those skilled in the art that corona starting voltage (i.e., the minimum voltage at which a corona will be produced) and current-voltage relationships in an electrostatic precipitator are directly proportional to the diameter of the discharge electrodes utilized. For any given diameter of discharge electrode held a predetermined distance from a collector electrode there is a corona starting voltage, or onset potential, and a higher-spark-over voltage, i.e., the voltage at which a spark will jump between the discharge electrode and the collector electrode. Thus a corona region is defined between the corona starting voltage and sparking voltage within which a corona will form. Corona onset potential increases as the diameter of the discharge electrode is increased and ultimately, an electrode diameter is reached at which the corona starting voltage equals the spark-over voltage. Continuation of the corona is not possible beyond this spark-over voltage. As a result, discharge electrodes of larger diameters have narrow corona regions and also decreased corona current. These disadvantages effect the efficiency of the precipitator and thus, since it is desirable to provide a wide corona region at a high corona current, it is necessary to use as thin an electrode (generally a wire) as possible.

Unfortunately, thin wire has very poor mechanical properties, as a discharge electrode, especially when used in a corrosive atmosphere which may be present in an electrostatic precipitator. In fact it has been found that thin wire discharge electrodes, in spite of their numerous advantages, are practically unusable for industrial applications. In light of this, many manufacturers of electrostatic precipitators make a compromise between the mechanical and electrical properties of discharge electrodes. As a result, numerous designs for discharge electrodes have been developed, including for example, special wires, barbed wires and stiff electrodes such as are disclosed in U.S. Pat. No. 3,485,011 to Archer et al. In spite of such efforts by manufacturers to improve the design of discharge electrodes for use in electrostatic precipitators, they have all, so far as is known, fallen short of obtaining an optimum design.

Therefore, there still is a need for better designed discharge electrodes to provide improved corona characteristics and to increase precipitator performance.

Accordingly, it is an object of the present invention to improve corona characteristics of discharge electrodes in electrostatic precipitators. Another object is to improve corona homogeneity between a discharge electrode and a collection electrode of an electrostatic precipitator. Yet another object of the invention is to increase the voltage level at which sparking will occur in discharge electrodes. A further object is to conserve the mechanical properties of discharge electrodes to prevent electrical breakdown thereof.

In accordance with an aspect of the present invention, a discharge electrode for use with electrostatic precipitators and the like is provided which includes an elongated electrically conductive rod and an outer sheath enclosing the rod. The outer sheath is formed of alternate sections of electrically conductive and non-conductive materials supported in contact with the electrically conductive inner rod and with each other. By this construction the corona region for a discharge electrode of given diameter is increased and corona discharge forms at the outer corner of the interface between the conductive and non-conductive sections.

The above, and other objects, features and advantages of this invention, will be apparent in the following detailed description of several illustrative embodiments thereof which is to be read in connection with the accompanying drawings wherein:

FIG. 1 is an elevational view, partly in section, of a discharge electrode according to an embodiment of the present invention;

FIG. 2 is a view similar to FIG. 1 of an electrode according to a second embodiment of the present invention;

FIG. 3 is a perspective view of a discharge electrode according to a third embodiment of the present invention;

FIG. 4 is an end view of the sheath of a discharge electrode according to an embodiment of the present invention;

FIG. 5 is a view similar to FIG. 4 of another embodiment of the present invention; and,

FIG. 6 is a graph illustrating the corona voltage current curves of a conventional discharge electrode and of a discharge electrode according to an embodiment of the invention.

Referring to the drawings in detail, and initially to FIG. 1, a discharge electrode 10, in accordance with the present invention, is shown positioned centrally with respect to a cylindrical collection electrode 12. The core of discharge electrode 10 is formed by an electrically conductive inner metal rod 14 to which an appropriate electrical current is provided during operation of the electrode. Rod 14 is encased in and supports an outer cylindrical sheathing 16 mounted concentrically on the rod. Outer cylindrical sheathing 16 is alternately divided into electrically conductive sections 18 and dielectric or electrically nonconductive sections 20. The sections 18 and 20 are generally cylindrical or tubular members and the fit between these sections and rod 14 is made as tight as possible to maximize contact between the sheathing and rod. In turn, the sheathing sections 18 and 20 are held in tight end-to-end contact with each other by means of two nuts 22 and 24

threaded onto the ends 26 and 28, respectively, of rod 14.

As seen in FIG. 1, a corona 30 forms between discharge electrode 10 and collection electrode 12 when a suitable voltage, within the corona region of the discharge electrode, is applied to the two electrodes. The source of the corona 30 will always be the interface 32 between each of the conductive and nonconductive sheathing sections 18 and 20, respectively. For a positive corona, it has been found that the ideal length of the sections 18 and 20, in this embodiment of the invention, is 1.15 times the distance between the opposed surfaces of the discharge and collection electrodes 10 and 12, respectively. However, this is not a limiting ratio and other ratios may be used, resulting in varying degrees of performance. When a negative corona is utilized, the length of the sections with respect to the distance between the two electrodes is not critical, however, it is usually desirable to make the lengths of the sections as short as possible to obtain a better and more uniform corona current density.

Several types of material such as glass, ceramics or teflon may be used to form the dielectric (nonconductive) sections 18 of sheath 16. Similarly several different conductive materials may also be used to form rod 14 and sections 18. Different metals or alloys may also be used in the same electrode.

In another embodiment of the present invention, illustrated in FIG. 2, an electrode 34 is provided which includes nonconductive annular sections 36 having a larger diameter but smaller length than the alternate cylindrical conductive sections 38. As in the prior embodiment, these sections 36 and 38, tightly engage a conductive rod 14 and are held in tight contact with each other by nuts 22 and 24 threadedly engaged with the ends of the rod. Further, the corona in this and all other embodiments described herein is formed at the interface between the conductive and nonconductive sheath sections. It has been found that this embodiment of the discharge electrode of the present invention provides for better charging of extremely small dust particles and aerosols in electrostatic precipitators.

Another embodiment of the present invention, suited for use with high-frequency current, is shown in FIG. 3, wherein a discharge electrode 40 is illustrated having electrically conductive rod 42 forming its inner core. Rod 42 is encased in an outer sheathing 44 that is alternately divided circumferentially into conductive and nonconductive sections 46 and 48, respectively. Each of these sections is sector-shaped and has side walls 49 which extend radially outwardly with respect to rod 42. The nonconductive sections 48 are narrower than the conductive sections 46 (i.e., describe smaller angles) and extend beyond the outer surface of the conductive sections 46 as in the embodiment of FIG. 2. The sheathing 44 herein is also in intimate contact with rod 42 and the sectors 46 and 48 are located in contact with each other. These sectors may be clamped in place by end nuts as in the previously discussed embodiments or may be otherwise secured to rod 42.

It is noted that while the sheaths of the embodiments of FIGS. 1 and 2 have been described with respect to annular or cylindrical shaped sectors it is possible to vary the shape of these sheaths in accordance with operational requirements. For example, the conductive and nonconductive sectors of these embodiments may

be semi-circular in plan, as seen at 50 in FIG. 4 or even hexagonal, as seen at 52 in FIG. 5.

A discharge electrode constructed of semi-circular sheath sections is well suited for use the radiation chamber of a high frequency generator such as that disclosed and claimed by me in my copending U.S. Pat. application Serial No. 133,577 filed on Apr. 13, 1971, the disclosure of which is incorporated herein by reference. In use therein, the flat portion of the discharge electrode is placed against the wall of the radiation chamber. Moreover, when such electrodes are used in the high frequency generator of my copending application, the surfaces of the metal sections in contact with the dielectric components become recrystallized such that the work functioning the metal is lowered.

Referring now to FIG. 6, three curves are illustrated which show the relation between current and voltage in an electrostatic precipitator for two different discharge electrodes. The voltage in kilo-volts is plotted along the abscissa of the graph and the current is plotted in milliamps per centimeter length of discharge electrode on the ordinate.

One of the discharge electrodes tested was a conventional wire electrode of 6 millimeter diameter and the other was a discharge electrode constructed according to the embodiment of FIG. 1 herein and also having a diameter of 6 millimeters. Both electrodes were tested under normal room conditions by applying positive and negative potentials thereto. From these tests, Curve A was generated by applying negative potential to the conventional 6 millimeter wire with a corona region extending from the onset voltage  $0_1$  to the spark-over voltage  $S_1$ . No corona region was developed when a positive potential was applied to this wire. Curve B was obtained by applying negative potential to the discharge electrode constructed in accordance with FIG. 1 while, Curve C was obtained by applying positive potential to the same electrode. From FIG. 6 it is seen that this electrode developed corona regions from  $0_2 - S_2$  and  $0_3 - S_3$ , respectively.

It is thus seen that with the electrode of the present invention, having the same size as a conventional electrode, has a corona onset potential which is significantly lowered as compared to the conventional electrode while a higher current can also be maintained before spark-over occurs. As a result, an expanded corona region is obtained and a precipitator utilizing such an electrode is operated more efficiently. Further it is seen that the discharge electrode of the present invention can be used with both positive and negative potential while a corresponding conventional electrode cannot.

Although illustrative embodiments of the present invention have been described herein with reference to the accompanying drawings, it is to be understood that the invention is not limited to those precise embodiments, and that various changes and modifications may be effected therein by one skilled in the art without departing from the scope or spirit of this invention.

What is claimed is:

1. A discharge electrode comprising, an electrically conductive rod and an outer sheath formed of alternately arranged electrically conductive and electrically non-conductive sheath sections encasing said rod, said sheath sections being positioned in contact with said inner rod and in contact with each other;

5

said rod being a substantially straight longitudinally extending member;

said electrically conductive and non-conductive sections being generally annular members alternately arranged coaxially of each other along the longitudinal axis of said rod; and

the external diameter of said non-conductive sections exceeding the external diameter of said conductive section and the length of each of said conductive sections exceeding the length of each of said non-conductive sections.

2. A discharge electrode comprising, an electrically conductive rod and an outer sheath formed of alternately arranged electrically conductive and electrically non-conductive sheath sections encasing said rod, said

6

sheath sections being positioned in contact with said inner rod and in contact with each other;

said rod being a substantially straight longitudinally extending member;

said electrically conductive and non-conductive sections being generally sector-shaped members alternately arranged circumferentially about the longitudinal axis of said rod; and

said electrically non-conductive sectors describing a smaller angle than said electrically conductive sectors, with respect to said rod, and extending a greater distance radially outwardly from said rod than said electrically conductive sections.

\* \* \* \* \*

20

25

30

35

40

45

50

55

60

65