

## LIGHTNING PROTECTION FACILITY

### TECHNICAL FIELD

[0001]

The present invention relates to a lightning protection facility that dissipates ions into the air to decrease an electric field in the air for protecting a structure or the like from lightning strokes.

### BACKGROUND ART

[0002]

The proximity of an electrically charged thundercloud causes an electric field to be generated between the thundercloud and the ground. The electric field intensity grows until causing an electric breakdown in the air to generate an electric discharge between the thundercloud and the earth's surface. This is a lightning stroke. There have been known lightning protection facilities each having a charge dissipater installed on or around a structure to be protected from lightning strokes, and constructed to dissipate, into the air, charges (ions) of a polarity opposite to the polarity in a lower part of the thundercloud to decrease an electric field generated over the structure and thereby delay occurrences of the lightning strokes.

[0003]

In lightning protection facilities including a conventional charge dissipater, such a charge dissipater has a wire (hereinafter referred to as "dissipation wire") including short metal wires and a long metal wire to which the short metal wires are secured at a given interval. In such lightning protection facilities, the dissipation wires are installed on the rooftop of a structure to be protected from the lightning strokes, and

those dissipation wires are grounded via grounding wires in order to protect the structure from lightning strokes.

[0004]

Conventionally, the charge dissipater is installed via a bracket on the top of a structure. In a place with only a small area on the top such as that of a pylon, a required number of dissipation wires were unable to be installed. With this being a situation, there have been proposed umbrella-shaped charge dissipaters such as one disclosed in Patent Document 1 as one able to be installed in a place with only a small area.

RELATED ART DOCUMENT

PATENT DOCUMENTS

[0005]

Patent Document 1: US Patent No. 5043527

SUMMARY OF THE INVENTION

PROBLEM TO BE SOLVED BY THE INVENTION

[0006]

Lightning protection facilities including a conventional umbrella-shaped charge dissipater, however, are installed outdoors, and have a risk of their dissipation wire being disrupted due to self-induced vibrations or the like caused by the wind, icing, snow accretion or the like.

[0007]

It is an objective of the present invention to provide a lightning protection facility including an umbrella-shaped charge dissipater which can prevent damages of a dissipation wire thereof.

## MEANS TO SOLVE THE PROBLEM

[0008]

The present invention provides a lightning protection facility including a charge dissipater installed on the ground or on a structure and grounded via a conductive wire,

the charge dissipater comprising:

a plurality of arms extending in an umbrella fashion from a top end of a tower erected on the ground or on the structure;

a dissipation wire placed spirally or approximately concentrically to cross the arms; and

wire rods arranged between the neighboring arms so as to cross the dissipation wire.

## ADVANTAGEOUS EFFECTS OF THE INVENTION

[0009]

The present invention provides a lightning protection facility including an umbrella-shaped charge dissipater which can prevent damages of a dissipation wire thereof.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1A is a schematic view showing a lightning protection facility with a charge dissipater thereof mounted on a metal tower erected on the ground.

FIG. 1B is a schematic view showing a lightning protection facility with a charge dissipater thereof mounted on a metal tower erected on a structure.

FIG. 2 is a partially omitted perspective view showing an appearance of a

charge dissipater of a lightning protection facility according to a first embodiment.

FIG. 3A is a plan view showing junctions of a dissipation wire with a wire rod of the charge dissipater according to the first embodiment.

FIG. 3B is a cross sectional view taken along the A-A line of FIG. 3A.

FIG. 4 is a plan view showing a variation of the junctions of a dissipation wire with a wire rod of the charge dissipater according to the first embodiment.

FIG. 5 is a schematic view showing a variation of the dissipation wire of the charge dissipater according to the first embodiment.

FIG. 6 is a partially omitted perspective view showing an appearance of a charge dissipater of a lightning protection facility according to a second embodiment.

FIG. 7A is a plan view showing junctions of a dissipation wire with a wire rod of the charge dissipater according to the second embodiment.

FIG. 7B is a cross sectional view taken along the B-B line of FIG. 7A.

FIG. 8 is a plan view showing a variation of the wire rod of the charge dissipater according to the second embodiment.

## EMBODIMENTS FOR CARRYING OUT THE INVENTION

[0011]

Now, a lightning protection facility 1 according to the embodiments will be described with reference to the drawings.

As shown in FIG. 1A, the lightning protection facility 1 according to the present embodiments includes a metal tower (a tower) 2, a grounding wire (a conductive wire) 4, grounding portions 5, and a charge dissipater 10 (10A, 10B). The charge dissipater 10 (referred to also as “ion dissipater” or “ionizer”) is fixed to a top of the metal tower 2 erected on the ground, and is connected, via the grounding wire 4, with the grounding

portions 5 provided on or in the ground. As shown in FIG. 1B, the lightning protection facility 1 may be constructed in such a manner that the metal tower 2 erected on a structure 3 has a top with the charge dissipater 10.

[0012]

(First embodiment)

As shown in FIG. 2, a charge dissipater 10A according to the first embodiment has an umbrella shape, and includes: eight arms 12 fixed to a pole (tower) 11; a dissipation wire 13; and wire rods 14. Incidentally, the number of arms 12 is not limited to eight but may be more or less than eight. In FIG. 2, an illustration of the dissipation wire 13 is partially omitted.

[0013]

The pole 11 has a vertically extending columnar support portion 11a and a ring portion 11b fixed to the top end of the support portion 11a. The support portion 11a has a bottom end fixed to the top end of the metal tower 2 (see FIG. 1A and FIG. 1B). The ring portion 11b of an octagonal cylindrical shape has outer faces to which the arms 12 are fixed, respectively. The support portion 11a and the ring portion 11b are made of a stainless steel, for example.

[0014]

The arms 12 are made of a conductive material such as a stainless steel. The arms 12 curvingly extend downward from the outer faces of the ring portion 11b in an umbrella fashion. The arms 12 are arranged with equal spacings from each other. The arms 12 are constructed of steel materials combined together, to ensure strength. In FIG. 2, thick solid lines show outer sides of the arms 12 and thin solid lines show inner sides thereof. Although not illustrated, the neighboring arms may be connected

with each other by rigid metal members (for example, rod-shaped members).

[0015]

The dissipation wire 13 includes a wire portion 13a which is a stainless metal wire and barb portions 13b (projection portions) arranged on the wire portion 13a at equal intervals. Each barb portion 13b is V-shaped and has a bend (an acutely angular portion) joined to the wire portion 13a with free ends of the barb portion 13b directed upward. The wire portion 13a and the barb portions 13b are secured to each other by laser beam welding or the like.

[0016]

The dissipation wire 13 is placed to cross the arms 12 and disposed spirally. Also, the dissipation wire 13 is constructed so that there are provided approximately equal spacings S (see FIG. 2) between the vertically neighboring loops of the dissipation wire 13, between the neighboring arms 12. In addition, the dissipation wire 13 is connected at points (or at a single point) with the grounding wire 4 (see FIG. 1A and FIG. 1B).

[0017]

Incidentally, according to the present embodiment, an example is depicted in which only a single dissipation wire 13 is disposed spirally. However, a plurality of dissipation wires may be arranged approximately concentrically at a constant distance. In addition, the dissipation wire 13 is fixed to the arms 12 by welding or by predetermined metal fittings at places where the dissipation wire 13 and the arms 12 intersect. Further, according to the present embodiment, a dissipating space 13s is provided also at the top of the ring portion 11b. The dissipating space 13s increases an area where discharge occurs, enhancing a discharge effect.

[0018]

The wire rods 14 are made of a conductive material such as a stainless steel, and placed to cross the spaced loops of the dissipation wire 13. The wire rods 14 are arranged approximately in the middle between the neighboring arms 12.

[0019]

As shown in FIG. 3A, the wire rods 14 each have horizontal sections 14a parallel to the wire portion 13a of the dissipation wire 13 and perpendicular sections 14b perpendicular to the wire portion 13a, the horizontal sections 14a and perpendicular sections 14b being alternated to form a zigzag pattern. The horizontal sections 14a are of a same length. The perpendicular sections 14b are of a length equal to the distance between the neighboring loops of the dissipation wire 13.

[0020]

In these wire rods 14, their horizontal sections 14a are fixed at places to the wire portion 13a of the dissipation wire 13, by the connectors 15, respectively. In FIG. 2, the illustration of the connectors 15 is partially omitted.

[0021]

The connectors 15 are made of a metal, and, as shown in FIG. 3B, are approximately C-shaped in a cross sectional view. Each of the wire rods 14 and the dissipation wire 13 are inserted into a connector 15 through a cut formed in the connector 15, and then the connector 15 is crimped so that the wire rod 14 is secured to the dissipation wire 13.

[0022]

Incidentally, the shape of the wire rods 14 is not limited to one shown in FIG. 2 and FIG. 3A but may be one as a series of alternately inverted U-shaped wire rods 24A

and wire rods 24B as shown in FIG. 4, wherein one horizontal section 24a of each wire rod 24A, one horizontal section 24b of each wire rod 24B, and the wire portion 13a of the dissipation wire 13 are fixed together by corresponding one of connectors 25.

Incidentally, the connectors 25 may be made of a metal as are the above-mentioned connectors 15, and the fixing may be made by crimping).

[0023]

As having been described, according to the first embodiment, the charge dissipater 10A includes: the plurality of arms 12 extending in an umbrella fashion from the top end of the metal tower 2 erected on the ground or on the structure 3; the dissipation wire 13 placed spirally to cross the arms 12; and the wire rods 14 arranged between the neighboring arms 12 so as to cross the dissipation wire 13. According to this construction, the wire rods 14 are fixed to the dissipation wire 13. This suppresses wide variations in distance between the loops of the dissipation wire 13, and thereby prevents the dissipation wire 13 from vibrating greatly due to self-induced vibrations or the like and thus from being damaged.

[0024]

Further, according to the first embodiment, the wire rods 14 are each composed of horizontal sections 14a parallel to the dissipation wire 13 and perpendicular sections 14b perpendicular to the dissipation wire 13, the horizontal sections 14a and the perpendicular sections 14b being alternated to form a zigzag pattern. This zigzag-pattern formation makes it possible to reduce the number of places where the connectors 15 are crimped for fixation of the wire rods 14 to the dissipation wire 13. A reduction in manufacturing steps is thereby achieved. In the meanwhile, the first embodiment needs only one crimping place, whereas a second embodiment needs four.

Incidentally, the wire rods 24A and 24B also make it possible to reduce the number of crimping places.

[0025]

Also, according to the first embodiment, the wire rods 14 are each composed of the horizontal sections 14a parallel to the dissipation wire 13 and the perpendicular sections 14b perpendicular to the dissipation wire 13 alternated to form a zigzag pattern. This zigzag-pattern formation ensures a wider binding range R (see FIG. 3A) of the dissipation wire 13 in a lateral direction (a direction in which the wire portion 13a of the dissipation wire 13 extends), which more effectively dampens vibrations of the dissipation wire due to self-induced vibrations or the like.

[0026]

Further, according to the first embodiment, the dissipation wire 13 includes the V-shaped barb portions 13b. The V-shaped barb portions 13b make it possible to increase regions for securing the barb portions, thereby enhancing the discharge effect. Incidentally, because of the barb portions 13b being V-shaped, the distance between the loops of the dissipation wire 13 extending in a direction to cross the arms 12 can be reduced, so that the barb portions 13b can be increased in number, unlike linear barb portions 13c of FIG. 5 to be described later.

[0027]

The present invention is not limited to the foregoing embodiment, but, as shown in FIG. 5, for example, as a modification of the dissipation wire 13, a dissipation wire 13A may be employed which includes linear barb portions 13c in place of the V-shaped barb portions 13b. Incidentally, the barb portions 13c are secured to the wire portion 13a by laser beam welding or the like.

[0028]

Also, in the foregoing embodiment, an example is depicted in which the wire rods 14, 24A, 24B each are made of a metal material. However, materials of the wire rods 14, 24A, 24B are not limited to a metal, but may be a resin as long as it has a rigidity. In addition, the connectors 15 are not limited to ones made of a metal to be crimped, but may be ones made of a resin to be engaged with each other.

[0029]

(Second embodiment)

As shown in FIG. 6, a charge dissipater 10B according to a second embodiment employs wire rods 34 in place of the wire rods 14, 24A, 24B of the first embodiment that form a zigzag pattern. Incidentally, components similar to ones mentioned in the first embodiment are denoted by the same reference numerals and detailed descriptions thereof are omitted. In FIG. 6, as in FIG. 2, the illustration of the dissipation wire 13 is partially omitted.

[0030]

The wire rods 34 are made of a conductive material such as a stainless steel and placed to cross the spaced loops of the dissipation wire 13 between the neighboring arms 12. The wire rods 34 are arranged in the middle between the neighboring arms 12.

[0031]

As shown in FIG. 7A, the wire rods 34 is fixed to the dissipation wire 13 at places where they intersect, by metal connectors 35. Each connector 35 has an approximately cross shape in a plane view, and has a pair of first crimp portions 35a, 35a and a pair of second crimp portions 35b, 35b, the pair of first crimp portions 35a,

35a and the pair of second crimp portions 35b, 35b being integrally formed as a unit.

The first crimp portions 35a, 35a fix the dissipation wire 13 and the second crimp portions 35b, 35b fix the wire rods 34.

[0032]

As shown in FIG. 7B, the first crimp portions 35a are approximately C-shaped in a cross sectional view. The dissipation wire 13 is inserted into each of the first crimp portions 35a through a cut formed therein to fix the dissipation wire 13. Also, as for the second crimp portions 35b as well, a similar procedure is taken to fix the wire rods 34, not illustrated.

[0033]

As described above, in the charge dissipater 10B according to the second embodiment, like the counterpart according to the first embodiment, the wire rods 34 suppress wide variations in distance between the loops of the dissipation wire 13, and thereby prevent the dissipation wire 13 from vibrating greatly due to self-induced vibrations or the like and thus from being damaged.

[0034]

The present invention is not limited to the foregoing embodiment, but, as shown in FIG. 8, the wire rods 34 may be replaced with dissipation wires 44. The dissipation wires 44 are similar to the dissipation wire 13, and each include a wire portion 44a and a plurality of V-shaped barb portions 44b fixed to the wire portion 44a with spacings.

[0035]

As described above, according to the charge dissipater 10B including the dissipation wires 44, it is possible to provide regions for securing the barb portions 44b,

in addition to the regions for securing the barb portions 13b, thereby enhancing the discharge effect as compared to a case where the barb portions 13b alone are provided.

[0036]

Incidentally, in the second embodiment as well as the first embodiment, the V-shaped barb portions 13b, 44b may be replaced with linear barb portions (projection portions).

[0037]

In the foregoing embodiments, examples are depicted in which the wire rods 14, 24A, 24B, 34, 44 each are made of a metal material such as a stainless steel. However, materials of these members each are not limited to a metal, but may be made of, for example, a resin as long as it is rigid enough to prevent the dissipation wire 13 from vibrating greatly.

#### DESCRIPTION OF REFERENCE NUMERALS

[0038]

|          |                                  |
|----------|----------------------------------|
| 1        | lightning protection facility    |
| 2        | metal tower (tower)              |
| 3        | structure (architecture)         |
| 4        | grounding wire (conductive wire) |
| 10A, 10B | charge dissipater                |
| 11       | pole (tower)                     |
| 12       | arm                              |
| 13, 13A  | dissipation wire                 |
| 13a      | wire portion                     |
| 13b, 13c | barb portion (barb portion)      |

|                  |                       |
|------------------|-----------------------|
| 14, 24A, 24B, 34 | wire rod              |
| 14a, 24a, 24b    | horizontal section    |
| 14b              | perpendicular section |
| 15, 25, 35       | connector             |

## CLAIMS

1. A lightning protection facility including a charge dissipater installed on the ground or on a structure and grounded via a conductive wire,  
the charge dissipater comprising:  
a plurality of arms extending in an umbrella fashion from a top end of a tower erected on the ground or on the structure;  
a dissipation wire placed spirally or approximately concentrically to cross the arms; and  
wire rods arranged between the neighboring arms so as to cross the dissipation wire.
2. The lightning protection facility of Claim 1, wherein the wire rods each have horizontal sections parallel to the dissipation wire and perpendicular sections perpendicular to the dissipation wire, the horizontal sections and perpendicular sections being alternated to form a zigzag pattern.
3. The lightning protection facility of Claim 1, wherein the wire rods are dissipation wires.
4. The lightning protection facility of any one of Claims 1-3, wherein the dissipation wire includes a V-shaped projection portion.