April 20, 1965 S. N. SCHLEIN 3,179,740

CORONA ELIMINATION MEANS

Filed Dec. 20, 1962 2 Sheets-Sheet 1

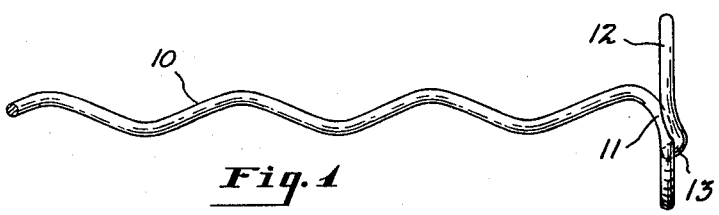

Fig. 1

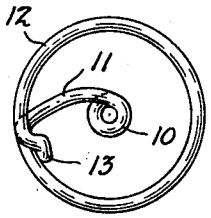

Fig. 2

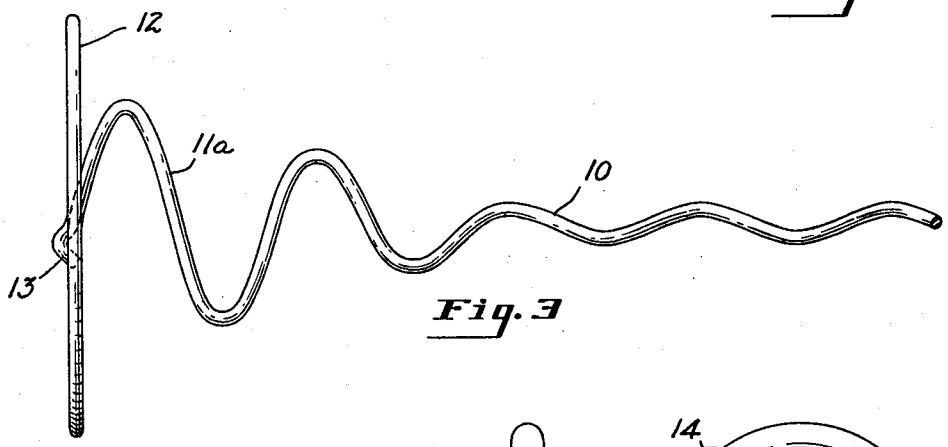

Fig. 3

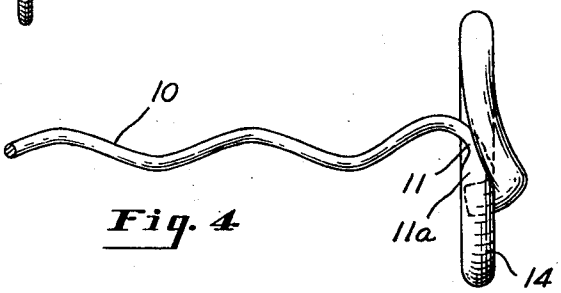

Fig. 4

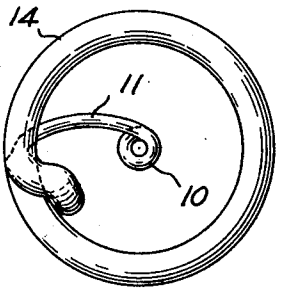

Fig. 5

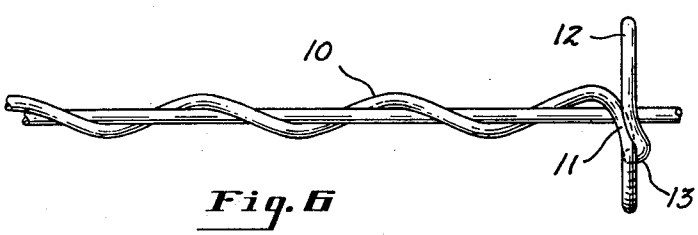

Fig. 6

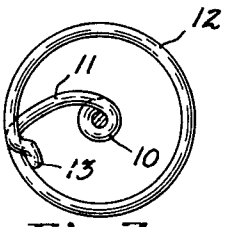

Fig. 7

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CORONA ELIMINATION MEANS

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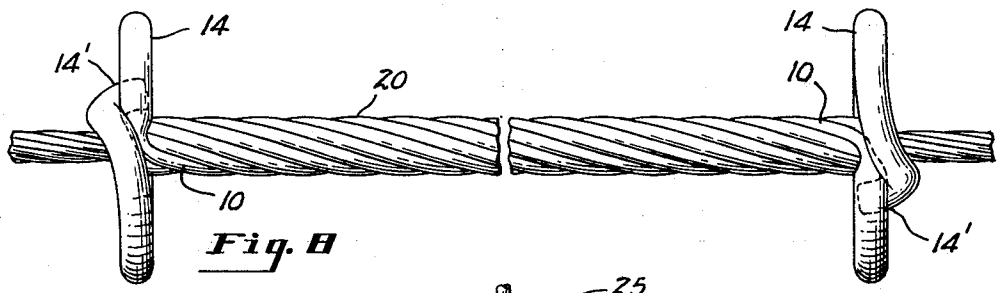

Fig. 8

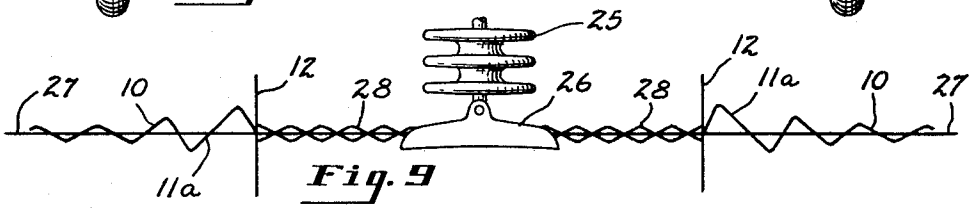

Fig. 9

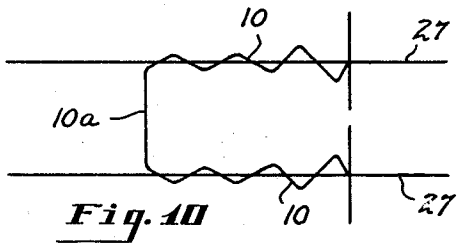

Fig. 10

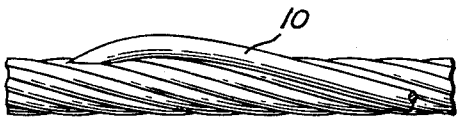

Fig. 11

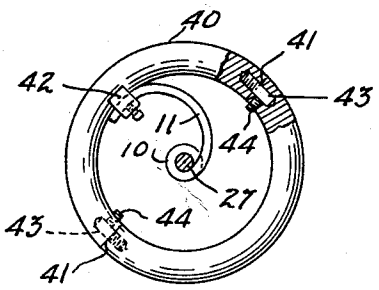

Fig. 12

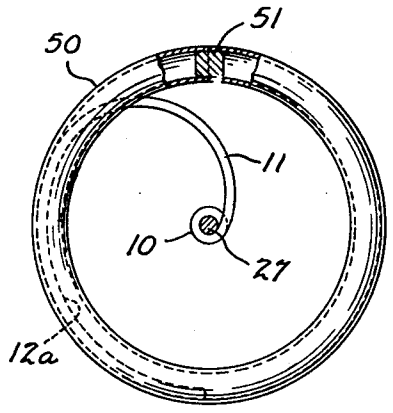

Fig. 13

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3,179,740

CORONA ELIMINATION MEANS

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Filed Dec. 20, 1962, Ser. No. 246,270
11 Claims. (Cl. 174—127)

This invention relates to improvements in devices for the elimination or suppression of corona on high voltage transmission lines.

As is well known to those versed in the art, the pressure of a high voltage on a transmission line can result in the causation of a corona discharge at places where the field is concentrated which is due to the ionization of the air in the immediate vicinity of the field concentration point on the conductor and resulting in an avalanche of electrons, which is a flow of current, and is manifest, particularly in the dark, as a corona discharge. This discharge is undesirable because it represents a loss of power, causes interference with the various types of communication systems, particularly radio communications, and also results in the production of ozone which increases deterioration of the line and its associated components.

In order to reduce corona losses, it has become common practice to utilize so-called corona rings at certain points on the line. In addition, corona may be reduced by multiplying and spacing the conductors to provide a system, called bundle conductors. The object in each instance is to reduce the field intensity surrounding a conductor.

One of the things that leads to the increase in corona discharge is sharp points on the conductors or its associated supporting appurtenances.

It has also become common practice to utilize what is known as "armoring" in conjunction with conductors. This may be used at the insulators to distribute the stresses over a longer length of the line and usually consists of a plurality of preformed helical armor rods which are wrapped about the line to provide an envelope which covers the line. The line is then secured to the insulators by suitable tie means which ties the armor rod envelope to the insulator. The same armor rods may also be used for splicing the lines and for other purposes.

It is apparent that the ends of the rods, even though rounded, result in a more or less pointed condition at which there is a high voltage concentration and which favors the formation of corona. Heretofore the more commonly known expedient has been to provide a ring which is attached to the line by a spreader wherein the ring surrounded the line in spaced relation thereto and whereby the high voltage field was conducted outwardly of the line and deconcentrated and the points of the armor rod were well within this deconcentrated field. These rings caused a larger area of distribution of the high voltage at these points and resulted in the elimination of the corona. The attachment of these rings was laborious and time-consuming. They were also expensive to make. An additional expedient included the use of a hollow ball which was secured around the line with the line passing through the ball at its diameter.

By the present invention I am able to combine a field distribution member which may be, but is not necessarily in the form of a ring, directly with the armor rods wherein the application is as simple as the installation of the rods themselves and the installation of the rods and the field distribution member or members is effected in one operation. The resultant structure is superior to the previous expedients because it is quicker, easier and

cheaper. Furthermore since the field distribution member may be an integral part of the armor rod assembly, the electrical contact with the line is not impaired as in the previous devices, and there is less chance of electrical leakage between the member and its point of attachment to the line.

Still other advantages of the invention and the invention itself will become more apparent from the following description of some embodiments thereof, which description is illustrated by the accompanying drawings and forms a part of this specification.

In the drawings:

FIG. 1 is a side elevational view of the combined armor rod and field distribution member of the invention;

FIG. 2 is an end elevational view thereof;

FIG. 3 is a modification thereof;

FIG. 4 is a fragmentary elevational view of another modification thereof;

FIG. 5 is an end elevational view of FIG. 4;

FIG. 6 is an elevational view showing the device applied to a fragment of a transmission line;

FIG. 7 is an end elevational view thereof;

FIG. 8 is a fragmentary elevational view of the device of my invention used in conjunction with a full lay of armor rods;

FIG. 9 is a diagrammatic view of an application of the invention;

FIG. 10 is a diagrammatic view of another application of the invention;

FIG. 11 is an enlarged fragmentary view of an end of one of the devices of the invention and showing a fragment of a line and its coaction therewith;

FIG. 12 is an end elevational view illustrating another embodiment of the invention; and

FIG. 13 is an end elevational view of another embodiment thereof.

In the drawings like parts have been designated by like reference characters.

Briefly, the invention contemplates an armor rod, which is a helical body arranged to be applied to a line without permanent deformation of the body, having at one end a portion that curves outwardly from the line and has integral therewith a field distribution portion which is coaxial with and spaced from the line, all in one integral unit. The opposite end of the rod from the field distribution element tapers down from the outer periphery of the helix to the inner diameter, eliminating any abrupt discontinuities at the end of the rod.

In its simplest form, as best shown in FIGS. 1 and 2, the device includes a line gripping body **10** which is in the form of an open helix. This helix has an inside diameter such that it will grip the line. The pitch of the helix is sufficiently open that it may be applied to the line from its side, without permanent deformation of the body.

At one end the body extends outwardly at **11** preferably, but not necessarily spirally, and terminates in a field distribution member in the form of a single convolution **12**, which is coaxial with the line. The extremity **13** curves inwardly and into the plane defined by the part **12**. The outwardly curved part **11** may be in the same plane as the plane of the convolution **12**, as shown in FIG. 2, or it may be a conical spiral or volute **11***a* as shown in FIG. 3. When applied to a line, as shown in FIG. 6, the convolution **12** provides a deconcentration of the high voltage field and thus prevents the ionization of the air and resultant corona discharge and shields the portions of the line or its appurtenances which may have abrupt or sharp discontinuity.

On high voltage lines, the effective cross-sectional area

of the field distribution element may be enlarged, as shown in FIGS. 4 and 5. In this instance, the body 10 may be the usual size, and at the point 11*a* where the spiral part 11 merges with the element 14 the material of the element 14 is of increased diameter or cross-sectional area as viewed transversely through one side of the element. This enlargement of the field distribution member can be effected by using larger stock for the element 14 and smaller stock for the spiral and body, or, the element 12 of FIGS. 1 and 2 can be enlarged by telescoping a tubular member over it. See FIG. 13. The outer sleeve may be swedged, welded or brazed to the inner body at the place where it joins it to prevent any abrupt discontinuities if desired. It could also be made of a conductive plastic material in the form of a sleeve which is slipped over the element 12, or, a plastic with a metallic coating on the outer surface.

In order to further reduce the corona generating points, the end 14' of the extremity of the element extends inwardly toward the inner diameter of the helix in such a manner that it is also shielded by the outer element. The other extremity of the helix 10 is rounded off longitudinally so that it gradually merges with the line, as best shown in FIG. 11. If desired, the inner surface of this end of the helix can also be made concave and the end bent slightly toward the line to cause the end to hug the line and form a close contact therewith.

Any of the devices of FIGS. 1, 2, 4 and 5 may be used in conjunction with conventional armor rods to completely encompass the line. In FIG. 8, two of the devices of FIGS. 4 and 5 are shown as being used in conjunction with a sufficient number of standard rods to provide a whole lay of rods around the line at 20. The devices are placed with their bodies, along with the other rods and with the field distribution members, being at the ends of the sets of rods and shielding all the rods against corona losses.

The composite structure thus made could be a splice or armoring as used at a pole. Thus the armoring and the static or corona prevention means are assembled in one simple and expedient operation without the need of special tools. In this respect, it will be apparent that the devices can be installed on "hot" lines with the standard hot line equipment as used today.

The device shown in FIG. 3, where the connection from the body to the field distribution member is volute, is particularly useful where it is desired to apply the ring opposite the ends of standard splices or other hardware such as the clamp suspension means used at a pole or tower. Such an example is shown diagrammatically in FIG. 9. In this instance, an insulator 25, which is suspended from a support, carries a saddle 26 in and through which the line 27, which is armored at 28, extends. A pair of the devices of FIG. 3 is placed on the line with the field distribution element 12 disposed over the ends of the armoring and with the body 10 extending beyond the armoring around the line. One of the anti-corona elements is used for each end of the armoring. It is apparent that if the line was supported directly by the saddle 26, without any armoring that the elements would be applied with the field distribution member surrounding the ends of the saddle.

In FIG. 10 the invention is shown as being used in conjunction with a line spacer. In this instance, two lines 27, which may be bundle conductors, are shown. The spacing is maintained by a pair of elements similar to that of FIG. 1, the ends of which are connected together by a bridge 10*a*. It will be apparent that the bridge 10*a* could be a separate member connected to the bodies 10 after installation.

FIG. 12 shows a device which is particularly useful in this type of installation, but not limited thereto. In this instance, the helix 11 is secured to a ring 40 by clips 42, which may be welded to the inner side of the ring. The ring is preferably split at 41 on opposite diametrical

sides. The half ring and its attaching body 10 could be secured to the line in the usual manner and then the ring completed by joining it with the other half ring. Suitable dowels 43 on opposite ends of the half rings extend into sockets in the other half ring and are held by set screws 44 placed within the protected field of the ring. With this type of device, the bodies 10 and the bridge 10*a* could be integral. It is apparent that the part 11 could be welded to the inner surface of the half ring.

It is to be particularly noted that with the device of the invention the weight of the field distribution member may be made less and that such weight as there is, is distributed over a large area of the line and not concentrated in one place as in conventional corona rings.

It is also pointed out that the ring, as depicted in FIG. 12, is not necessarily limited to use with line spacers, such as shown in FIG. 10, but may also be used with the body 10 and connector 11, replacing the member 12 or 14 in FIGS. 1 and 4.

A particular advantage of the conductive plastic member, as described in connection with FIGS. 4 and 5, is that it is much more pliable and that therefore the end 14' of the convolution may be displaced from the start of the convolution 11*a* to allow the parts to be spread apart when it is applied to the line. After application, the parts return to their normal position with the end 14' in proximity to the start 11*a* of the convolution.

Another embodiment of the device is illustrated in FIG. 13, and contemplates that the field distribution member be a flexible conductive ring. In this instance, the ring is split and one end of the ring 50 is provided with a socket and the other end with a projection 51. The resiliency allows the ends to be forced sufficiently far apart that the parts may be passed around the line for installation purposes. The spiral connector part 11 would extend into the interior of the ring and be secured at the entrance by welding or some similar expedient, or it could be secured to the inner surface of the ring by clips, or, when the ring is metal, by welding. The ring may be hollow and of a resilient metal. It may also be filled with a filler if desired. The spiral 11 may extend into the ring a considerably large distance, as illustrated by the dashed lines at 12*a*, to thus hold the ring in its desired position. It also provides greater resistance against distortion when it is made of conductive plastic. If desired, a resilient former could be placed inside of the ring and coextensive with the extra ring when it is made of the softer plastics, whether conductive or having a conductive coating. The spiral connection portion 11 also distributes stresses and absorbs shocks within this portion, thus lengthening the lift of the device, due to the fact that there are no points of concentrated stresses, as in the prior art.

Although the invention has been described in some specific embodiments thereof, it will be appreciated that numerous and extensive departures may be made therefrom by those versed in the art, without departing from the spirit or scope of the invention as defined in the appended claims.

I claim:

1. An apparatus of the class described comprising a preformed electrically conductive helical member having an internal diameter of the helix such that when applied to a high voltage line the adjacent convolutions are in tightly gripping relation with the line for at least more than one pitch length and having a pitch of the helix such that it may be applied to the line without permanent deformation, said member having a portion at the end which terminates in an electrical field distribution member formed by a continuation of the helical member of greater diameter than the helix disposed in a plane normal to the axis of the line.

2. A device as described in claim 1, wherein said field distribution member has a cross-sectional diameter on a radius through the member greater than the diameter of a cross-section on a radius through the helix.

3. A device as described in claim 1, wherein the helix merges with a spiral formation at the end and the field distribution member is supported on the end of the spiral portion.

4. A device as described in claim 3, wherein said field distribution member is a ring that is of flexible electrical conductive material and is split and means is provided at the ends of the ring at the split for interlocking engagement of the ends.

5. An apparatus of the class described comprising a preformed electrically conductive helical member having an internal diameter of the helix such that when applied to a high voltage line the adjacent convolutions are in tightly gripping relation with the line for at least more than one pitch length and having a pitch of the helix such that it may be applied to the line without permanent deformation, said member having a portion at the end which curves outwardly in a spiral and terminates in an electrical field distribution member of greater diameter than the helix which has at least one convolution coaxial with the axis of the line and with the member being disposed in a plane normal to the axis of the line.

6. A device as described in claim 5, wherein said spiral portion is of volute formation.

7. A device for the elimination of corona losses on a high voltage power transmission line which comprises an electrically conductive rod bent into the form of an open helix with at least more than one adjacent convolution of the helix being such that it may be applied to the line without permanent deformation and having a portion at one end extending outwardly from the line and formed into a substantially closed convolution substantially larger than the diameter of the line and having an enlarged cross-sectional diameter larger than the body of the helix and having its free end extending within the central plane defined by said convolution.

8. In combination with a high voltage transmission line, and means for reinforcing said line comprising a plurality of preformed resilient electrically conductive armor rods disposed in surrounding relation on said line, and each comprising an open helix having an inside diameter slightly less than the diameter of the line and an open pitch such that they may be applied to the line without permanent deformation and thereby tightly grip the line, at least one of said helical members having a portion on the end which extends outwardly away from the line and merges with an electrical field distribution member extending around and coaxial with the line and extending in a plane normal to the line.

9. A device as described in claim 8, wherein a transverse dimension through said member at any point is substantially larger than that of a transverse section through the helical member.

10. A device as described in claim 9, wherein said rods with the field distribution members are disposed with at least one member at each end of the group of rods.

11. In combination with spaced high voltage transmission lines, means for holding said lines in spaced relation to each other and reducing corona around the lines comprising electrically conductive helical elements disposed around the lines in holding engagement therewith, means extending between the helical members and connected to the ends thereof for holding them in spaced relation to each other, each of said helical elements having a portion at the end which extends outwardly from the line and a field distribution member supported thereby coaxial with and in spaced relation to and surrounding the line.

References Cited by the Examiner

UNITED STATES PATENTS

1,690,185	11/28	Wahlberg	174—144 X
1,813,151	7/31	Eaton	174—144
1,972,616	9/34	Austin	174—144 X
1,999,273	8/35	Austin	174—127 X
2,000,673	5/35	Terman	174—73 X
2,789,154	4/57	Peterson	174—127 X
2,959,632	11/60	Peterson	174—42 X
2,999,894	9/61	Binder	174—42 X
3,087,008	4/63	Ruhlman	174—127 X

FOREIGN PATENTS

68,509	10/44	Norway.
639,040	6/50	Great Britain.

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