May 3, 1927. 1,626,777

A. O. AUSTIN

HIGH POTENTIAL CONDUCTOR

Filed June 26, 1924 2 Sheets-Sheet 1

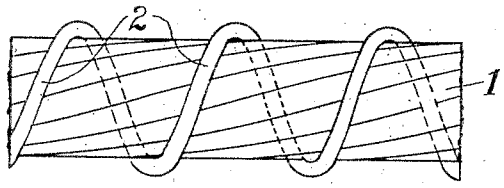


Fig 1

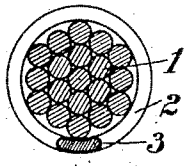


Fig 2

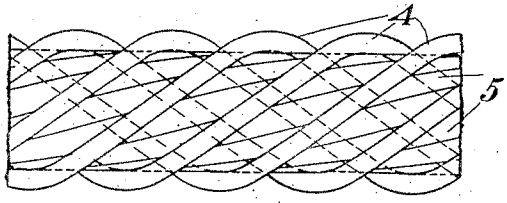


Fig 3

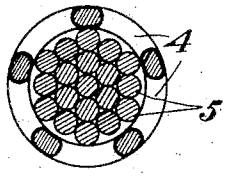


Fig 4

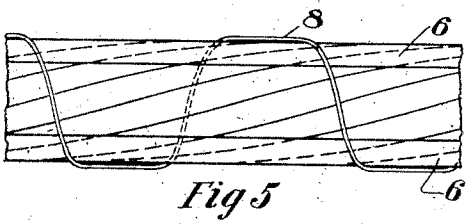


Fig 5

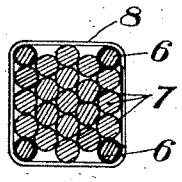


Fig 6

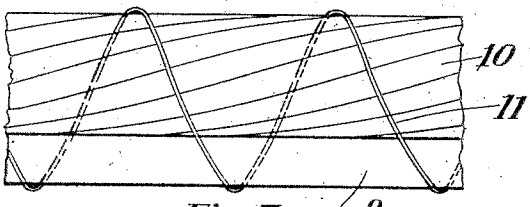


Fig 7

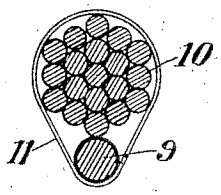


Fig 8

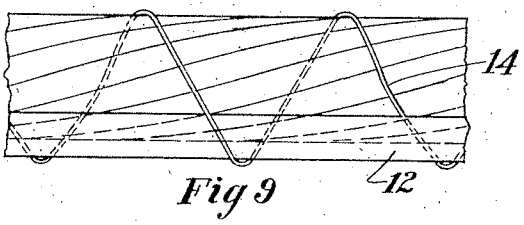


Fig 9

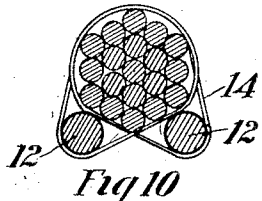


Fig 10

INVENTOR

BY Arthur O. Austin

Nissen & Crane

ATTORNEYS

May 3, 1927. 1,626,777

A. O. AUSTIN

HIGH POTENTIAL CONDUCTOR

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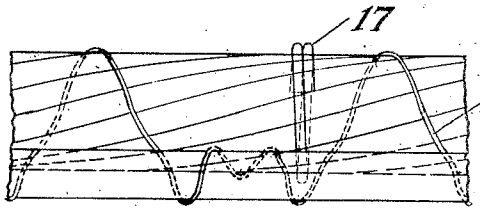


Fig 11

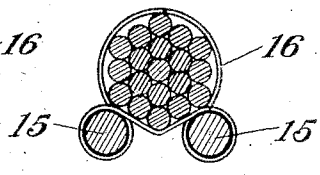


Fig 12

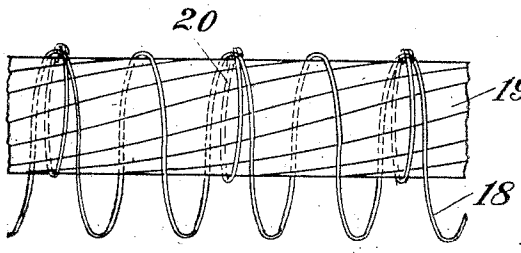


Fig 13

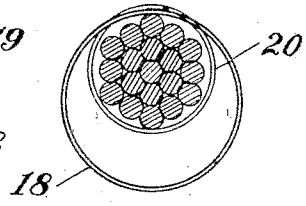


Fig 14

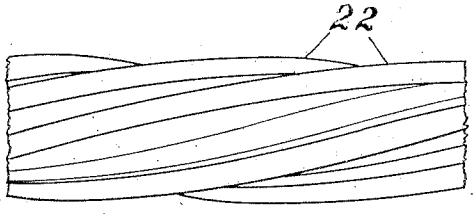


Fig 15

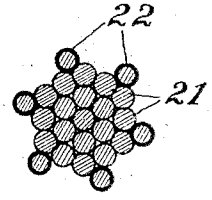


Fig 16

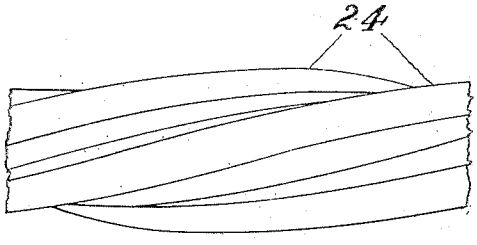


Fig 17

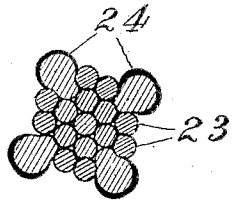


Fig 18

INVENTOR
BY Arthur O. Austin
Niven & Crane
ATTORNEYS

Patented May 3, 1927.

1,626,777

UNITED STATES PATENT OFFICE.

ARTHUR O. AUSTIN, OF BARBERTON, OHIO, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE OHIO BRASS COMPANY, OF MANSFIELD, OHIO, A CORPORATION OF NEW JERSEY.

HIGH-POTENTIAL CONDUCTOR.

Application filed June 26, 1924. Serial No. 722,440.

This invention relates to conductors for reducing corona losses at high voltages and has for its object the provision of conductors which shall be mechanically and electrically efficient and in which the losses due to corona will be reduced.

The invention is exemplified in the combination and arrangement of parts shown in the accompanying drawings and described in the following specification and it is more particularly pointed out in the appended claims.

In the drawings—

Fig. 1 is an elevation of a portion of a conductor having one embodiment of the present invention applied thereon.

Fig. 2 is a transverse section of the conductor shown in Fig. 1.

Figs. 3 and 4 are views similar to Figs. 1 and 2 showing another form of the invention.

Figs. 5 and 6 are views similar to Figs. 1 and 2 showing another form of the invention.

Figs. 7 and 8 are views similar to Figs. 1 and 2 showing another form of the invention.

Figs. 9 and 10 are views similar to Figs. 1 and 2 showing another form of the invention.

Figs. 11 and 12 are views similar to Figs. 1 and 2 showing another form of the invention.

Figs. 13 and 14 are views similar to Figs. 1 and 2 showing another form of the invention.

Figs. 15 and 16 are views similar to Figs. 1 and 2 showing another form of the invention.

Figs. 17 and 18 are views similar to Figs. 1 and 2 showing another form of the invention.

In transmission at high voltages the discharge into the air or corona loss is an important economic factor. Since the amount of power which can be transmitted over a conductor with a given percentage loss increases as the square of the voltage, it is highly important that a high voltage be used in order to reduce the size of the conductor and lower the cost of the transmission line. For a given amount of power, by increasing voltage, the size of the conductor can be decreased with the same percentage of loss. If the voltage is high, however, the small size conductor may discharge into the air and the increased loss offset economic gains in reducing the size of the conductor.

Where very high voltages are used, large smooth conductors may operate with small corona loss. Under storm conditions, however, the smooth conductor may have a very rough lower edge formed by the drip water running off of same. With a smooth conductor, this water tends to run off in much larger streams; hence, the losses may really be greater and the danger of arcing to ground may be materially increased, as against a conductor which has a fairly uniform roughness which will break up the drip water into small quantities.

The conductors shown in Figs. 1, 2, 3, 4, 13, 14, 15 and 16 accomplish this result by the main corona pressing strands, whereas the attaching or binding members hold the corona pressing strands to the main conductor tend to accomplish the same result in Figs. 5, 6, 7, 8, 9, 10, 11, and 12. A small conductor which will break up the drip water may have lower losses and be less likely to permit an arc to form from conductor to ground than a very large smooth conductor where the latter permits a concentration of the drip water at fewer points. Not only does the concentration of the drip water from a larger conductor tend to cause discharge or increase the losses but the larger projected area of the large conductor tends to increase the amount of drip water and the length of the stream falling from the conductor. With a larger radius of curvature, there is also, less tendency to break up the stream of drip water.

In most installations it is, therefore, necessary to effect a careful compromise between the operating voltage, the cost of the conductor and the line losses, which include ohmic losses as well as corona losses. By transmitting at high voltage it would be possible to use a relatively small conductor, and in many cases a conductor of relatively poor conductivity but of good mechanical properties might be used to advantage.

If the size of the conductor, however, is too small, the losses will be high and the compounds formed by the discharge will tend to destroy the conductor.

In addition to the installations where the

amount of power transmitted will hardly warrant a large conductor, there are installations where the loss is likely to be very considerable from corona discharge, owing to the very high voltage used. This loss is greatly increased where the altitude is high or under storm conditions where the conductor is wet.

In a very large conductor, the brush discharge tends to start abruptly at some point on the voltage wave and may cease abruptly. This tends to set up oscillations which it would be desirable to eliminate. The corona discharge is due to a high electrostatic stress in the air. This stress may be reduced by increasing the size of the conductor or by substituting a material which has a higher dielectric strength than air.

Where the projected area of the conductor is large, the amount of water intercepted during a rain may be considerable. Even though the conductor is quite large, the water falling off the lower part of the conductor forms an exceedingly sharp edge and tends to increase the loss. This tends to offset the benefit of the large diameter.

In very large conductors there is also a tendency for the discharge to be less uniform than in the case of the small conductors; hence, a discharge at any point on the large conductor may be larger and project further into the air than in the case of the small conductor. This is due to the fact that in the small conductor there is a mutual screening effect owing to the numerous discharges which re-act upon each other, while in the large conductor the absence to a large extent of such screening action permits a streamer or discharge to affect a larger electrostatic field. This tends to offset the advantage of the large conductor and it is therefore highly advisable to prevent discharge from the larger size of conductor as well as the smaller size of conductor.

If the entire conductor could be covered with an insulation which should have a greater strength than that of air, the desired result would be obtained. It would be practically impossible, however, to maintain insulation of this kind owing to the cost and aging of the same. A very material effect, however, may be obtained by providing a few conductors which project beyond the outer layer of the main conductor and covering the projecting conductors with insulation such as insulating enamel, rubber, guttapercha or other suitable material. In order to obtain a material benefit it is not necessary that the insulation be continuous on the projecting conductor constituting the control or corona suppressing strands.

In general, the covering of a conducting surface with insulation with greater dielectric strength than that of air permits the projection of this conductor further into the electrical field, in order to provide a screening action for suppressing discharges from electrodes or conducting surfaces in this vicinity, the inner portion of the insulated control being connected electrically to the body which it is desired to protect.

Figs. 1 and 2 show one method of producing the desired result. The conductor is composed of a main conductor 1 similar to that generally used for transmission work, the one shown in the drawing comprising a plurality of strands. A strand 2 having a covering 3 of dielectric material is wound around this conductor 1 so as to project outwardly from the surface. The distance between turns of the winding 2 may vary in accordance with the result desired. In place of a single strand, two or more strands may be used. These strands may be wound in the same direction and may conform to the lay of the cable, or, the individual strands may be wound in opposite directions to each other. Where a few strands only are used twisted around the conductor, these strands may be installed by proper equipment even after a cable is in position. The corona suppressing strand 2 may have little or no insulation on the inner surface where it comes in contact with the main conductor. It matters little whether electrical contact is established at the time that the strand is put on or not as insulation will be broken down by the charging current and this will effect good contact. If a conducting strand is used, a drop in potential along the main conductor will also insure contact between the core of the protecting strands and the main conductor. It is usually not necessary to make a definite metallic contact between the conductor and the core of the corona suppressing strands for the reasons stated above, although this may be accomplished in several different ways. If there is no contact at the time of installation, vibration will tend to maintain a contact surface, particularly if the corona suppressing strands are wound loosely about the main conductor.

Figs. 3 and 4 show the several corona suppressing strands or elements, the number 4 designating the corona suppressing strands and 5 the strands of the main conductor. These strands may be wound with the same lay as the main conductor or in opposite directions. If wound in an opposite direction, it is usually advisable to apply varnish or material which will cause the strands to maintain their relative position unless they are close together. When wound in a lay corresponding to that in the cable they will tend to stay in proper position, although it may be advisable to wrap the conductor with a protecting material until time of installation.

Figs. 5 and 6 show a similar construction to that in the other figures with the excep-

tion that the corona suppressing strands 6 may be supported parallel with the axis of the main conductor or spiraled around it. The corona suppressing strands 6 are held to the main conductor strand 7 either wholly or partially by a small wire or binding strap 8 wound around same. This binding member should preferably be of insulating material, although it may be of metal in the form of a bare wire or member covered with insulation as in the case of the corona suppressing strands 6. Any equivalent construction such as rings or stampings may be used for the purpose. If the corona suppressing strands have a high degree of insulation they may be located at some distance from the conductor as in Figures 7 and 8. In Figures 7 and 8 the construction is somewhat similar to that in Figures 5 and 6 except that a single corona suppressing strand 9 is used hung below the conductor. This strand may be spaced from the conductor and attached to the same mechanically only at frequent intervals. This strand will tend to minimize the discharge from drip water. In this case 9 is the corona suppressing strand, 10 is the main conductor and 11 the mechanical connecting means between the corona suppressing strand and the main conductor.

In Figs. 9 and 10 two protecting strands 12 are shown so that the drip water may fall directly from the main conductor and not from the corona suppressing strands. With this arrangement, less insulation is required on the corona suppressing strands as the drip water tends to leave the main conductor strands 13 directly rather than from the corona suppression strands 12. The corona suppressing strands 12 are preferable spaced from the main conductor strands 11 by a small strap or holding means 14.

Figs. 11 and 12 show one method of attaching to the main conductor which will tend to hold the corona suppressing strands 15 at a distance from the main conductor. The attaching means 16 may be in the form of water resisting cord or wire or metallic members may also be used, as they are needed only at intervals sufficient to obtain proper spacing. Where the attaching member 16 is a poor conductor, electrical contact between the core of the suppressing conductor 14 must be established occasionally. This may be done by several turns of wire 17 or a little metal ring placed about the conductor which will come in contact with the inner edge of the corona suppressing strands 15 and establish contact.

Where a considerable amount of protection is desired or very quiet operation is desired, as around bus structures, a construction shown in Figs. 13 and 14 may be used to advantage. In this case the corona suppressing element 18 is made up in the form of a helix having a much larger diameter than the main conductor 19. The member 18 may be attached to the main conductor 19 by another wrapping 20 so as to keep the turns of the helix in proper position.

The strands of the corona suppressing elements may be made in a number of different ways without changing the principle of the invention. One method is to apply a layer of material which may be impregnated with a varnish or insulating material to increase its dielectric strength or to provide water protection, such as cotton wrapping impregnated with linseed oil or an insulating varnish. Even though there may be some deterioration in time, it is a comparatively easy matter to coat the outer portions of the strands with the conductor in place, providing the material is such that it will absorb or pick up the coating material readily when applied. In some forms the corona suppressing elements can be removed as new ones are applied, as the amount of material required is relatively small. This can be done without necessarily killing the main line.

Not only do corona suppressing strands tend to cut down the corona losses which may be a very important factor, but they tend to raise the voltage at which an arc will strike from the conductor to ground. This tends to reduce the danger of grounds on the system.

Figs. 15 and 16 show the conductor made up having corona suppressing strands 22 having the same lay as the main conductor strands 21. Figs. 17 and 18 show a conductor having the corona suppressing strands 24 meshed with the main conductor strands 23. This arrangement tends to prevent the displacement of the corona suppressing strands.

I claim:

1. In an electrical transmission line for high potentials a current carrying conductor having portions disposed along the length thereof and projecting beyond the main contour of said conductor, said projecting portions being electrically connected with the main body of said conductor and covered with dielectric material to reduce corona loss in said conductor.

2. In an electrical transmission line for high potentials a current carrying conductor having a plurality of peripherally projecting longitudinally extending ribs, said ribs having electrical connection with said conductor and having the outer portion thereof covered with dielectric material to reduce corona losses.

3. In electrical transmission lines, a current carrying conductor having a strand thereof projecting beyond the main contour on the conductor but in electrical connection therewith, the outer portion of the projecting

strand being covered with dielectric material.

4. In high potential transmission lines, a bare conductor and a strand of dielectrically covered material wound upon said bare conductor said strand having electrical connection with said conductor.

5. In high potential transmission lines, a bare current carrying conductor and a plurality of strands of dielectrically covered conductor material wound upon and in electrical connection with said bare conductor and arranged in spaced relation about the periphery thereof.

6. In high potential transmission lines, a conductor comprising a plurality of strands all in electrical contact, one of said strands having its outer portion arranged to project beyond the contour of the conductor formed by the other strand, said projecting portion having its outer surface covered with dielectric material.

In testimony whereof I have signed my name to this specification on this 21st day of June A. D. 1924.

ARTHUR O. AUSTIN.