Dec. 28, 1926. 1,611,871

A. O. AUSTIN

HIGH TENSION INSTALLATION

Filed Oct. 20, 1921 2 Sheets-Sheet 1

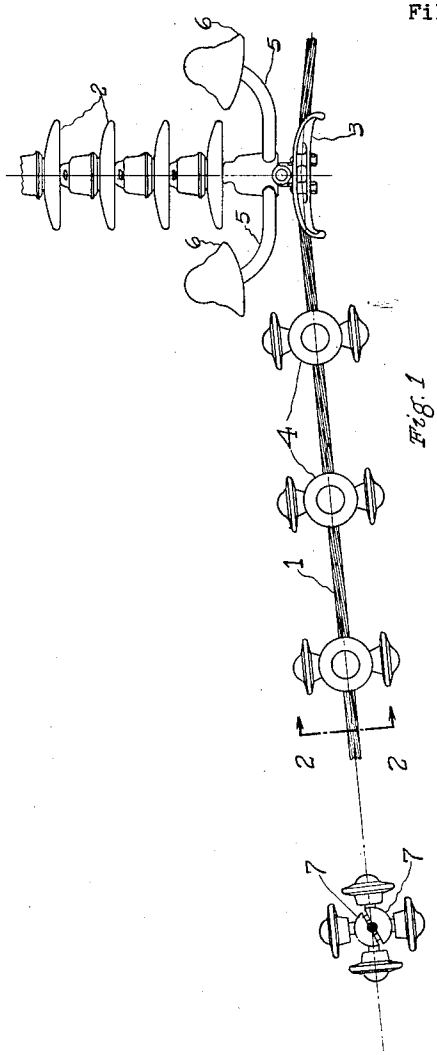


Fig. 1

Fig. 2.

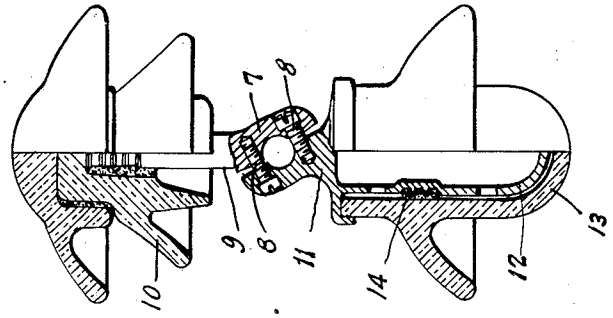


Fig. 3.

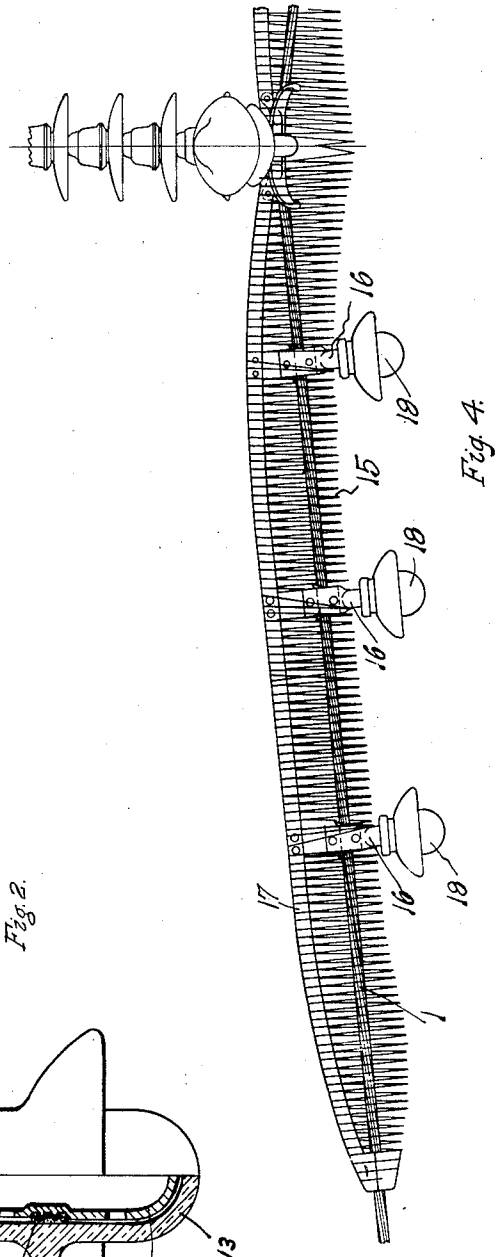


Fig. 4.

INVENTOR

BY Arthur O. Austin

Nissen & Crane

ATTORNEYS

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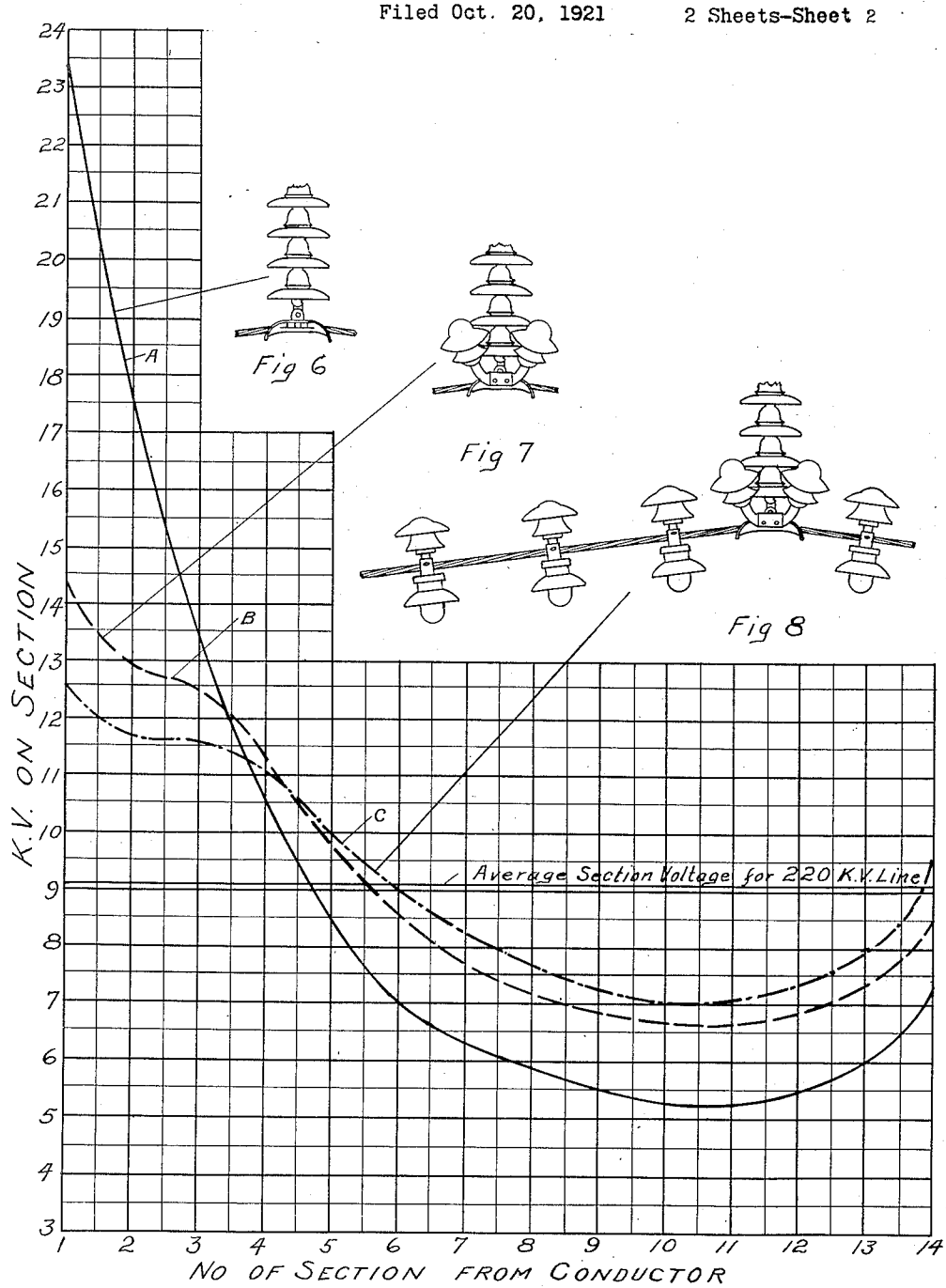


Fig 5

Fig 6

Fig 7

Fig 8

INVENTOR
Arthur O. Austin
BY Kissen & Crane
ATTORNEYS

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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-TENSION INSTALLATION.

Application filed October 20, 1921. Serial No. 508,934.

This invention relates to installations for high electrical potentials, such as high tension transmission lines, wireless apparatus, and other constructions, and has for its object the provision of mechanism of the class named which shall be of improved construction and operation and which shall reduce the tendency to discharge of various characters from the highly charged conductors through the control of the electro-static flux in the medium surrounding such conductors.

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 an installation embodying one form of the present invention;

Fig. 2 is a section on line 2—2 of Fig. 1;

Fig. 3 is a section showing one of the control members forming a part of the invention illustrated in Fig. 1; and

Fig. 4 is a view similar to Fig. 1 of a modified form of the invention.

Fig. 5 is a graphic curve showing the effect of the invention on the operation of a high tension line.

Figs. 6, 7 and 8 illustrate the conditions corresponding to the curves in Fig. 5.

In high tension insulators customarily used a six or eight section suspension insulator will ordinarily withstand a greater voltage at a high frequency without danger of arcing than will the conductor on which the voltage is impressed, unless the conductor is of abnormally large size. It is, of course, not economical to use a conductor which is so large that the first cost and interest on the investment will be excessive, therefore abnormally large conductors are not feasible. Even if there were sufficient power to warrant a very large conductor for transmitting power at a high voltage, the line reactance due to the large current necessary for economy would be too great to permit of a size sufficiently large to prevent arcing of the conductor in the vicinity of the supporting tower where the electro-static field is strong. Spreading or splitting the conductor into several parts so as to increase the effective diameter would be of material benefit, but this is open to serious mechanical objections when carried out throughout the line or in the vicinity of the tower.

The insulators next the transmission lines carry higher electro-static stress than those farther from the line due to what may be termed the leakage of electro-static flux to ground from different members in the series. The use of a very large conductor in the vicinity of the insulator tends to prevent or make up for this loss of electro-static flux, thereby greatly improving the stress distribution or gradient for the insulating member or members. The gradient or stress distribution in the series may be improved by horns or flux controls, as shown in my previous application, Serial No. 476,179, filed June 9, 1921, or by a large ring or shield. Where a ring or shield is used to control the flux this ring or shield may lower the flash-over voltage owing to its projecting into a strong field on the tower side so that the lowered flash-over voltage may more than offset the advantage of an improved gradient in the insulator.

An eight or ten section insulator of good design will usually withstand a higher voltage than that which will start an arc from the conductor to the tower, a distance of from five to ten feet, depending upon electrical conditions, although the length of the insulator may be only half this value. From this it will be seen that using a long string of insulators may be of little benefit in providing a larger factor of safety, as an arc may start from the conductor to the tower. This invention is designed to prevent this arcing from conductor to tower by raising the voltage to which arcing or pluming will occur and at the same time reduce the danger of arcing of the insulator string.

Owing to the comparatively small diameter of the conductor and the comparatively short distance to the tower, there is a very strong field about the conductor in the vicinity of the tower so that by increasing the effective diameter of the conductor by means of a properly formed shield or screen running along or adjacent to the conductor, the stress in the air is lowered and the corona

point or voltage necessary to start a plume or arc may be greatly raised and the danger of pluming or arcing to ground under high frequency disturbances may be greatly reduced or eliminated.

There are two classes of discharge into the air from insulators or high voltage conductors. One class affects the performance of transmission lines very seriously due to the arcing to ground at voltages much lower than would be indicated by the voltage which can be carried at normal frequency. Where a discharge from a conductor into the air is in the nature of a small streamer, the resistance of the streamer will be greatly reduced by increasing the current in the same. As this current may be regarded as a charging current the air acting as a dielectric in a condenser and a streamer as one of the conducting plates, it will be seen that by increasing the frequency the current in the streamer will be increased accordingly. Since, however, increasing the current in the streamer greatly reduces its resistance, the voltage drop along the streamer will be less, consequently the high stress of the conductor will be carried out further from the conductor. This will cause a further breakdown of the air, permitting an increase in the electro-static capacity of the condenser which affects the current and resistance of the streamer acting as one of the electrodes of the condenser. This further increase in current again reduces the resistance so that an accumulated effect is produced which is very serious when a high frequency is impressed upon the line or insulator. This may be better understood when we consider that doubling the current in the streamer may easily cut its resistance in half.

From this it will be seen that while the resistance in a streamer might be excessively high at a normal frequency of twenty-five or sixty cycles, the same length of streamer would have almost a negligible resistance if the frequency is increased several thousand times, which might easily occur on the transmission line. This increase in frequency over the normal frequency may come from a number of different causes, such as lightning, an arcing ground, the effect of corona on the line in producing a harmonic, the harmonics produced by connected apparatus by switching or other causes. A discharge then which will cascade because of the accumulative effect of current, either due to the reaching of a sufficiently high voltage, or partially due to the increased current from an increased frequency, or a combination of both, may cause serious arcing or at least arcing to ground at voltages much lower than would otherwise be the case.

A small diameter of conductor, as was pointed out, permits a highly concentrated field which tends to produce streamers at comparatively low voltages. These streamers may exist at or even below the normal transmitting frequency. While there may be no trouble from the same other than the loss of power at normal frequency, an increase in frequency, particularly when attended by an increase in voltage, may permit of the growth of a streamer resulting in an arc to ground, as previously explained. Where the size of the conductor is increased the concentration of the field is reduced, and even though a streamer starts, the accumulative effect will not be so great and a much higher voltage and frequency may be impressed without producing a plume or arc which will go to ground under a disturbance, permitting the energy of the line to follow.

Where the size of a conductor is so small or the gradient so steep that a high voltage will cause arcing from the conductor to tower or ground, the gradient at the surface of the conductor may be materially improved by the use of an insulated flux control attached to conductor and projecting into the field. These controls may be made in a variety of forms, such as lenticular discs threaded on the conductor and having charged inner surfaces or cylindrical or tubular members having insulated covering and placed near the conductor and connected thereto, or by members of conducting material projecting at approximately right angles from the conductor and provided with insulating coverings or members. One method of attaching such controls is shown in Fig. 1 in which the numeral 1 indicates a conductor supported by a series of insulators 2 to which the conductor is connected by a saddle 3. The conductor is provided with control members 4 at spaced intervals therealong and may also be provided with control horns 5 adjacent the insulator, the ends of the horns being covered by insulators 6. The control members spaced along the conductor may comprise a pair of clamps 7 secured to the conductor by screws 8, as shown in Fig. 3. Extending from the clamp 7 are projecting members, such as pins 9, having an insulator 10 carried on the end thereof. This insulator may be of the usual pin type, as shown at the top in Fig. 3, or may be of a special construction, as shown at the bottom in this figure, in which the projection 11 carries a shell 12 covered by an insulating member 13 and secured thereto by cement 14. These forms are shown by way of example, and other forms of control members will readily suggest themselves to those skilled in the art.

In Fig. 4 the conductor 1 is shown as surrounded by a cage of screening or similar material designated by the numeral 15, similar to that shown in my co-pending

application, Serial No. 508,933, filed October 20, 1921. Control members are distributed along the conductor 1 and secured thereto, by clamps 16 which also support a stay 17 for the cage. The control members are covered by insulators 18. The insulated control so used may be made of one or more insulating members in series and attached to the conductor singly or in groups, depending upon result desired. The insulated control so used limits the current in accordance with the laws of the condenser so that a streamer from the insulated control can only develop into a plume at an excessively high voltage which will cause the control member to flashover or puncture. The principal object of the insulated control applied to the conductor is to raise its pluming or arcing voltage. The insulated control when applied to the conductor is very effective in developing a high pluming voltage under both wet and dry conditions even for a small conductor.

The following example will show how effectively this control may be in raising the voltage of a combination. Without insulated controls on the conductor, 490 k. v. at 35,000 cycles caused an arc from the conductor to the tower, a distance of approximately nine feet. By improving the gradient or limiting the current in streamer along the conductor with insulated controls shown in Fig. 1, it required 580 k. v. to cause the combination to arc. In addition to increasing the arcing or pluming voltage of the conductor, the insulated control also improves the distribution of stress in the insulator.

In curve A, Fig. 5, is shown the voltage duty for a 14 section suspension string for an applied voltage equivalent to 220 k. v. line voltage. Curve B shows the voltage duty with insulated controls at the insulator only. Curve C shows the voltage duty for the various sections with insulated controls on the conductor. It will be seen that the insulated controls in addition to improving the gradient around the conductor and increasing the voltage necessary to cause flashover to ground, in addition improves the voltage duty or gradient in the string or insulator. The insulated control has the advantage in that it does not necessarily cut down effective clearance and lower the arcing voltage as in the case of a bare metallic guard or control. Furthermore, the insulating covering permits a control member to extend further into the field causing a greater screening or shielding. Under wet conditions the streamers tending to start from the surface of the control are limited owing to balancing resistance and electro-static capacity in series with same, consequently a streamer will not develop into a plume or power arc as readily as in the case of a bare conductor, and yet the streamer may be of such magnitude as to effect a considerable favorable stress distribution. For this reason, the insulated control may be used to advantage in combination with a conductor guard as shown in Fig. 3, particularly where there is danger of discharging on the lower side and where it is not advisable to increase the diameter of the metallic guard owing to cutting down of clearance, increasing the electro-static capacity to ground or other cause.

By placing the insulated conductor controls near the insulator and clamp they may be used to raise the pluming voltage of the conductor and clamp or to improve the gradient or eliminate static discharge from clamps or attachments.

I claim:—

1. The combination with a conductor, of spaced electro-static control members thereon, said members comprising conductors extending laterally from said first-mentioned conductor, said laterally extending conductors having the outer portions thereof covered with insulating material.

2. The combination with a conductor, of a supporting insulator therefor, and electrostatic control members carried by said conductor and spaced thereon, said control members comprising devices of conducting material extending laterally from said conductor and having the outer portions thereof covered with insulating material.

3. The combination with a conductor, of a supporting insulator therefor comprising a series of units, flux control means for said insulator, and flux control members distributed along said conductor adjacent said supporting insulator, said flux control members comprising conducting devices extending laterally from said conductor and having the outer portions thereof covered with insulating material.

4. Means for increasing the carrying voltage or potential of a conductor by the control of the stress in the air, comprising electrodes the surfaces of which are covered by insulating members having greater dielectric strength than the surrounding medium.

5. Means for increasing the carrying voltage or potential of a conducting member or surface said means comprising condensers to control the field about the conductor or surface one side of each of said condensers being in electrical contact with the conductor or surface and the other side of each condenser terminating in the insulating medium surrounding the conductor or surface.

6. Means for raising the discharge voltage of a conductor by controlling the electrostatic field said means comprising electrodes covered by insulating members arranged to form condensers, one surface of each of said condensers being in electrical contact

with the conductor and the other surface of each condenser terminating in the surrounding medium.

7. Means for preventing discharge from a conducting surface comprising electro-static condensers made up of conducting members and insulating members, one of the conducting members of each condenser being in contact with the conducting surface and the opposite side of the condenser terminating in the surrounding medium.

8. The combination with a conductor of outwardly extending electrodes distributed along the conductor in position to lower the concentration of stress in the air adjoining said conductor, the ends of said electrodes being covered with material having greater dielectric strength than air.

9. The combination with a conductor of outwardly extending electrodes connected therewith said electrodes being covered with a series of insulating members.

10. A conductor having outwardly extending electrodes connected therewith and covered with a series of insulating members and arranged to raise the voltage necessary to arc through the surrounding medium.

11. Means for preventing discharge into the surrounding medium from an electrical conductor supported by an insulator, said means comprising electrodes placed along said conductor, said electrodes being covered with insulating members having greater dielectric strength than the surrounding medium and arranged to improve the gradient of the insulator support for the conductor.

12. Means for controlling the discharge voltage of a conducting surface comprising a control condenser made up of conducting members and insulating members one of said conducting members being in electrical contact with the surface the discharge voltage of which is to be controlled and the side of the control condenser away from said surface being free in the surrounding medium.

13. Means for improving the distribution of stress in a supporting insulator for a conductor comprising a control condenser made up of insulating members and electrodes one of said electrodes being in electrical contact with the surface of said conductor and the other side of said condenser terminating in the surrounding medium.

14. The combination with an insulator and conductor supported thereby of a control condenser for controlling the field adjacent said conductor and insulator, said condenser being made up of electrodes and insulating members, one side of the control condenser being in electrical contact with the conductor and the other being free in the surrounding medium.

In testimony whereof I have signed my name to this specification on this 12th day of October A. D. 1921.

ARTHUR O. AUSTIN