Jan. 7, 1930. S. BARFOED 1,742,628

HIGH TENSION INSULATOR

Filed May 11, 1927

Fig. 1.

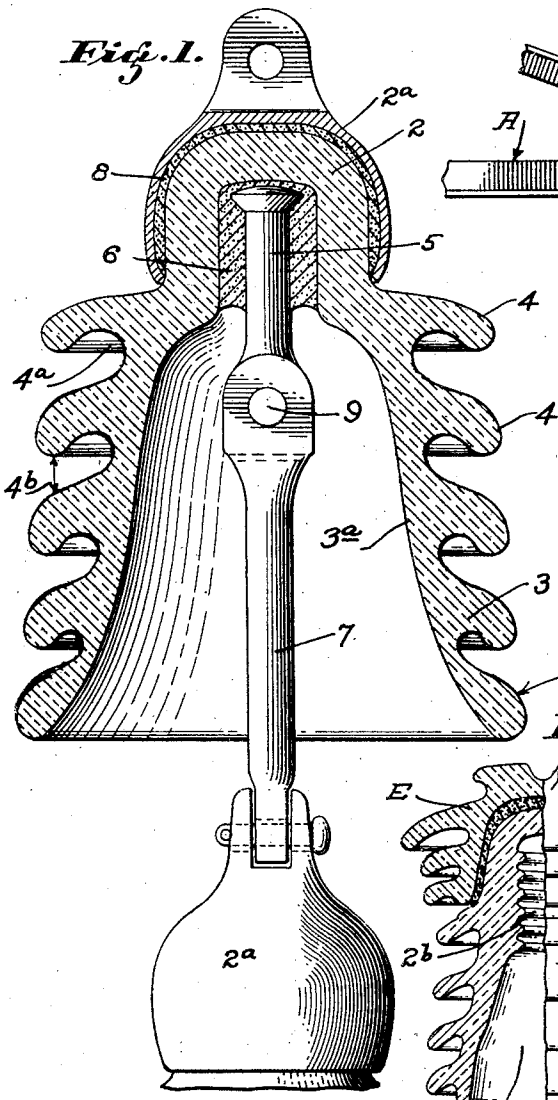


Fig. 2.

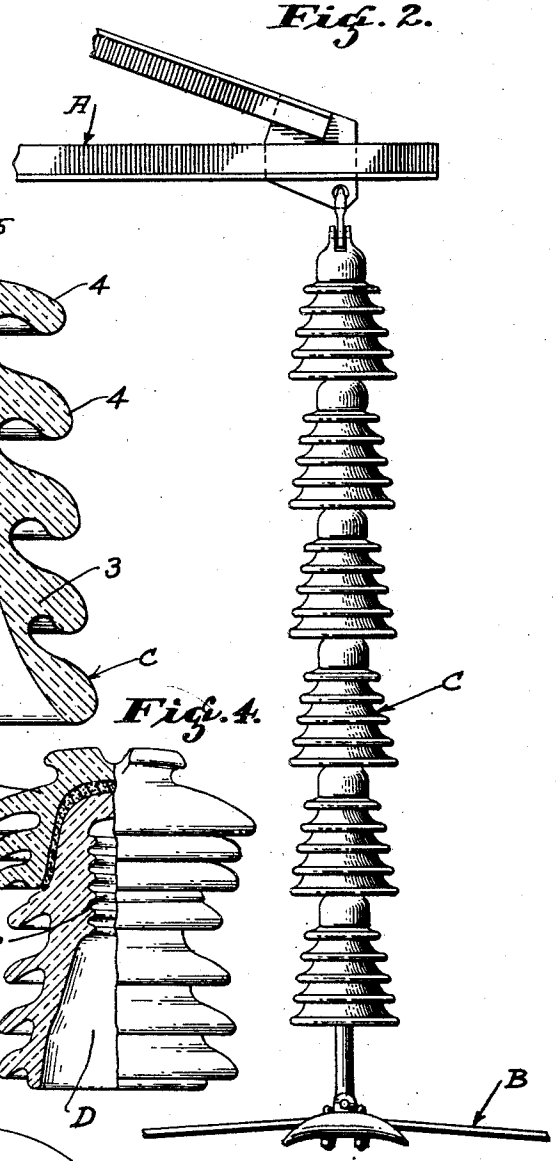
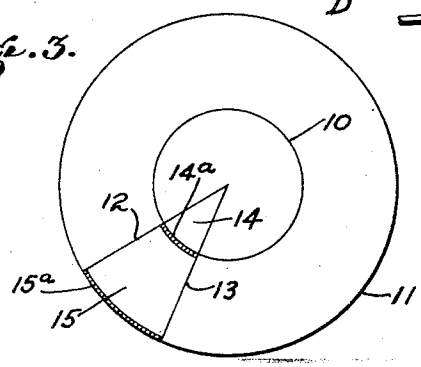


Fig. 4.

Fig. 3.



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UNITED STATES PATENT OFFICE

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HIGH-TENSION INSULATOR

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This invention relates to insulators and particularly that kind employed for high tension electric transmission lines. These insulators may be either what is known as the suspension type or the pin type.

To safely insulate high tension transmission lines in districts where fog and dust conditions alternately prevail for long periods, serious difficulties have been encountered. Fog, dew, mist and light rain, in combination with dirt and dust render insulator surfaces of the usual shape conducting to a degree where it becomes, at times, difficult to keep a transmission line in operation.

When a series of the suspension type insulators of the common disc shape were used, it did not help matters to any appreciable extent by merely adding further units to the string, nor did it improve conditions to enlarge the diameter of the units of either the suspension type or the pin type.

By adding further units to a suspension string of insulators, the electrical potential distribution amongst the units composing the string is rendered worse than before and the string tends to fail by cascading around the highly stressed units unless the potential distribution is again corrected by exterior antennaes and devices, such as grading rings, etc., which for most lines would be prohibitive in cost. Further, the string length has thereby become so great that ground clearances to the supporting tower or pole is reduced to the danger point, and if again brought to a proper value, the tower or pole must be made much stronger, will weigh more, and the cost of construction correspondingly increased.

By increasing the diameter of either type of insulator, in order to provide increased leakage distance for the moisture and dirt conditions as above described, a point is very quickly reached where increased diameter actually means increased leakage. This is demonstrated as follows: Assume a plane circular solid disc of insulating material and of unit diameter, then render its surface partially conducting to the electric current by moisture and dust, and then apply an electric potential to electrodes in the center on either side of the disc. Now consider a sector of the disc of unit center-angle and observe that the leakage current finds in its path a conductor cross-section of ever increasing value towards the edge of the disc. The ability, per unit length, of the partially conducting surface to absorb the impressed potential is, therefore, reduced in direct proportion to the lengths of the radius as the edge of the disc is approached.

By now making the diameter of the disc two units instead of one unit, the ability of this extra length of leakage path to absorb electric potential is still further reduced, and if this process is continued the condition of short circuit is approached rendering the increased surface of no value as an insulator. This method of providing leakage distance has, therefore, resulted in complete failure.

The present invention is based on the discovery that leakage of the electric current may be greatly reduced if the exposed area or insulating surface upon which dust and moisture can collect is reduced to a minimum by reduction of diameter of the insulating body, combined with increased axial length of the insulating body and protection of the exposed insulating surface by corrugations or skirts of small diameter and of a definite shape and prescribed spacing and disposition. It was discovered that to increase the leakage path by merely introducing skirts on the body of the insulator or building the insulator up of a number of shells or skirts is beneficial in an economical manner for the dirt and moisture conditions only, when the shells or skirts are disposed with relation to each other and to the main body of the insulator in a definite manner. The manner in which this maximum insulating value of the skirts or shells is obtained is by so spacing them and giving them such form that for the dust and moisture conditions a balance is obtained between the value of the sparking distance through the air between the rims of the skirts and the leakage distance along the surface of the insulator from rim to rim of skirts. It has in this manner been possible to produce insulators which have an insulating value when moist and dirty which is only 20% less than the insulating value of the same insulators

when perfectly dry and clean. To obtain this result the air space between the skirts assume a shape which in cross-section in a radial plane shows the rims of the skirts are closer together than the roots, and depending upon the conditions to be met, such for instance as, proximity to cement plants, railroad yards, also in arid, dusty countries and in combination with moisture in the form of dew, fog, salt fogs, mist or light rain, the relation between the distance or air gap from edge to edge of rims of the skirts and the leakage distance along the surface of the insulator from edge to edge of rims may vary. For instance, in case of ordinary dust and fog the relation would be one to four, and for salt fog, one to five, etc.

The invention is shown by way of illustration with accompanying drawings in which:

Fig. 1 is an enlarged central vertical section through one of the insulators.

Fig. 2 shows a string or assembly of insulators and a conductor suspended therefrom.

Fig. 3 is a diagrammatic view illustrating the fallacy of increasing the diameter of disc type insulators.

Fig. 4 is a side elevation partially in section, showing a pin type insulator.

Referring to the drawings in detail, and particularly Fig. 1 and Fig. 2, A indicates the cross-arm of a transmission line tower or pole of suitable construction; B the conductor carrying the high tension current and C a string of insulators from which the conductor is suspended. The type of insulator employed is that illustrated in Fig. 1. It consists of a head portion 2 and a petticoat or skirt portion 3. This skirt portion is slightly flared or bell-shaped and its exterior surface is provided with a suitable number of superposed interspaced annular flanges or petticoats. These petticoats are of substantially equal diameter and an exterior corrugated cylindrical surface is the apparent result.

The head member 2 is hollow to receive an anchor bolt 5 which is secured by a cementitious material as indicated at 6. The anchor bolt carries a link 7 and this is, in turn, connected with a metallic head member 2^a which encloses the head 2 of the insulator and is secured thereto by a cementitious material 8, or the like. The connections between the head members 2^a and the anchor bolts 5 are preferably pivotal, as indicated at 9, and a flexible string of insulators is obtained.

The method of anchoring the bolts 5, the head members 2^a and the manner of attaching the link 7 is of no importance and may be changed to suit varying conditions. The manner of forming the annular petticoats 4 on the exterior surface, the spacing employed between the annular flanges and the proportional area and length obtained is, however, of great importance and forms the subject matter of the present application. As previously stated, the invention is based on the discovery that leakage losses in a transmission line may be materially reduced if the exposed area or insulating surfaces upon which dust and fog can collect is reduced and the length of the leakage path increased.

To clearly illustrate and describe this feature, reference will be made to Fig. 3. In this illustration the inner circle 10 represents a plan view of the type of insulator illustrated in Fig. 1 and the circle indicated at 11 represents a plan view of a disc type of insulator which has been increased in diameter. By dividing these circles into a segment, as illustrated by the lines 12 and 13, it will be noted that the triangle indicated at 14 represents a defined and total area upon which dust and fog may collect and that the remainder of the triangle, indicated at 15, represents the increased area upon which dust and fog may collect, if the diameter of an insulator is increased.

It is well known that the resistance to the flow of an electric current depends upon the cross-sectional area of the conductor. If this is decreased, the resistance increases and if the area is increased, the resistance is materially reduced. Again, it is well known that the length of the conductor also increases or decreases resistance.

By referring to Fig. 3, it will be supposed that dust and moisture has collected on the surface of the insulator to about a thickness of one-thirty-second of an inch. If this is the case, the cross-sectional area of the dust at the base of the triangle 14, and indicated at 14^a, will represent a much smaller area than a cross-section taken at the base of the triangle 15, such as indicated at 15^a. Hence, the amount of material collected on the area 14 will afford a much greater resistance to the flow of current than the material collected on the area 15, as the cross-sectional areas presented are small in one instance and comparatively large in the other instance, and thus by progressively increasing the diameter of the discs the annular surface for each unit increase in diameter will be less and less able to sustain its share of the impressed potential, and when eventually the diameter of the discs are made very large, this leakage value per unit length of leakage path will be so low that short circuit conditions per unit length will be approached, resulting in an uneconomical deposition of the insulating material.

By constructing the insulator, as shown in Fig. 1, the diameter of the annular flanges or petticoats 4 are maintained as small as possible, thereby presenting small surfaces for the collection of dust and fog, with a consequent reduction in cross-sectional leakage area and by elongating the insulator as by providing the skirt portion 3 and additional

annular flanges 4 the length of the leakage path is materially increased without increasing the cross-sectional area of the leakage path, hence ideal insulating conditions are obtained.

Another important feature of the present invention is the spacing maintained between the annular flanges or petticoats 4 and the shape of the annular channels 4^a formed between the same. It was discovered that to increase the leakage path by merely introducing skirts or petticoats on the body 3 of the insulator or building the insulator up of a number of shells is beneficial in an economical manner for the dirt and moisture conditions only when the shells or skirts are disposed with relation to each other and to the main body of the insulator in a definite manner. The manner in which this maximum insulating value of these skirts or shells is obtained is by so spacing them and giving them such form that for the dust and moisture conditions, a balance is obtained between the value of the sparking distance through the air between the rims of the skirts and the leakage distance along the surface of the insulator from rim to rim of the skirts. It has, in this manner, been possible to produce insulators which have an insulating value when moist and dirty, which is only 20% less than the insulating value of the same insulators when perfectly dry. To obtain this result, the air space indicated at 4^b between the skirts assuming a shape which in cross-section in a radial plane shows the rims of the skirts are closer together than the bases, this distance depending upon the conditions to be met, such for instance, as proximity to cement plants, railroad yards; also in arid, dusty countries and in combination with moisture in the form of dew, fog, salt fog, mist or light rain. The relation between the distance or air gap from edge to edge of rims of the skirts and a leakage distance along the surface of the insulator from edge to edge of rims may vary. For instance, in case of ordinary dust and fog, the relation would be approximately one to four, and for salt fog, one to five.

From the foregoing it should be noted that the skirt 3 is so shaped as to be provided with an inner protected surface 3^a on which little or no dirt and moisture will collect and that the outer surface is to a large extent protected by the petticoats 4, which are so formed and arranged as to obtain proper air space between the superposed petticoats and at the same time provide a protection for the exterior surface of the skirt 3 to reduce the amount of dust and moisture collected. Briefly, the spacing between the petticoats 4 is such that leakage resistance over the surface when covered with dirt and fog is substantially equal to the air resistance formed vertically between the superposed petticoats, as indicated at 4^b, thus producing a balanced design of economic proportions. That is, with a given quantityy of insulating material shaped and proportioned as here described, efficient insulating qualities or conditions are obtained with a minimum of insulating material, this being also important as a material weight reduction is obtained and cost of manufacturing is reduced. The type of insulator employed is not limited to suspension insulators but may also be employed where pin type insulators are required, as shown in Fig. 4. Only one section, such as indicated at D, is employed where comparatively low voltages are encountered but one or more shells such as indicated at E may be added when higher voltages are encountered. The pin type of insulator, whether constructed in one or two sections, is identical in construction to the suspension type illustrated in Fig. 1 and a detailed description thereof is accordingly thought unnecessary. Suffice it to say that the interior of the head 2^b may be threaded to receive the upper threaded end of the supporting pin. This is, of course, an old feature and forms no part of the present invention.

While certain features of the present invention are more or less specifically described and indicated, I wish it understood that various changes may be resorted to within the scope of the appended claims; similarly, that the materials and finish of the several parts employed may be such as the manufacturer may dictate or varying conditions or uses may demand.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. An insulator of the character described having a body portion, and a plurality of annular interspaced superposed flanges formed on the exterior surface thereof, the spacing between said flanges being such that the air gap resistance between the flanges shall be substantially equal to the leakage path between the flanges when their surfaces are covered with dust and moisture.

2. A suspension insulator of the character described, having an elongated body portion open at the lower end and closed at the top, and a plurality of annular interspaced superposed flanges formed on the exterior surface of the body portion, the exterior diameter of said flanges being substantially equal and presenting a substantially cylindrical corrugated exterior surface, said flanges having a spacing which is greatest adjacent their base and less between the peripheral edges the said spacing being such that the air gap resistance between the adjacent peripheral edges shall be substantially equal to the leakage path formed between the flanges when their surfaces are covered with dust or moisture.

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