CIRCULAR DISTRIBUTION OF CORONA CURRENT OF MULTIPLE CONDUCTOR TRANSMISSION LINE (Ⅱ)

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1. Introduction

For the research of corona characteristics on the multiple conductor transmission line described in this paper, a special coaxial cylindrical electrodes was used as a model.

The outer cylindrical electrode is divided into thirty-six segments which are each insulated each other by means of small insulating gaps and circular distribution of corona current from the model of the multiple conductor placed at the center of the cylindrical electrode was investigated. The results of measurements through this equipments was reported in the author's[1] [2] paper "Distribution on the corona current on the multiple conductor transmission line (1)" . Bulletin of Nagoya Institute of Technology, Volume 12, 1963. This report comprises the results of successive measurements and some conclusions obtained from these experiments.

The same equipments and methods as reported in the above paper was applied for the measurements in this paper. This time, however, the diameter of one element conductor of double con ductor was kept constant, where 0.5 mm brass wire was used and the diameter of the other element conductor was varied from 1.45 mm to 4.00 mm, and in some cases, PVC insulated wire or a insulator string having same corresponding diameter was used in place of the second conductor element. Through these experimental measurements, the following results were obtained.

In case one of the double conductor was replaced by P. V. C. wire of same diameter, same distribution curve of corona current as that of double conductor was obtained, while in case one of double conductors was replaced by a string of insulator model of same diameter, the characteristics of circular distribution was completely different.

2. Equipments and Results of Experiments

The detail of the equipments and the methods of measurements for this research were reported in the former Report 1, and only the different points used in the measurements of this paper are abridged herein.

One of the different points is for the purpose of measuring small corona current on circular electrode segments shielded by other conductor elements, a micro-micro ammeter was used.

Figure 1 shows the model electrode, for the measurements of distribution characteristics of corona current, and inside of cylindrical electrode is covered by thirty-six segmental electrodes. The results of the measurements were shown in the characteristics in Fig. 3 to Fig. 8.

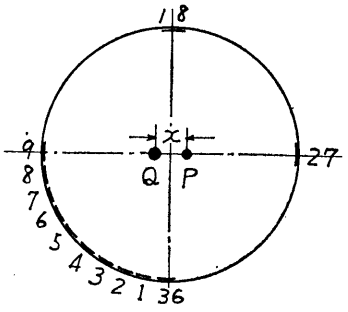


Fig. 1. Coaxial cylindrical electrode

2-(1) Circular Distribution of DC corona Current from Double Conductor of Different Diameter

In conventional transmission line of double conductor, the element conductors of same diameter are arranged parallel and spaced at a certain distance by means of spacers.

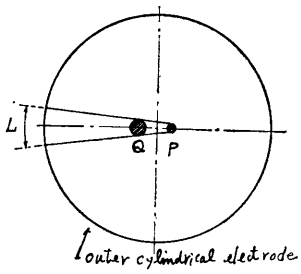
When the diameters of two element conductors are different, the circular distribution characteristics of corona current around the conductors should be different from that in case of the same diameter.

At the concentric cylindrical electrode model as shown in Fig. 2 where P is a conductor of small diameter and Q is the larger one, the corona starting voltage from P is lower than that from Q.

For the conductor P, 0.5 mm diameter brass wire was used for the conductor Q, the conductor of five varied diametres 1.60, 1.95, 2.95, 4.00, 4.45mm was used. The space between the two conductors was kept constant at 5 mm.

Circular distribution curves of corona current from the double conductor of the above combinations are shown in Fig. 3A and B.

Fig. 3-A shows the curves when positive DC voltage was applied, and B, negative.



Conductor P···0.5mm ϕ Brass wire

Conductor Q··· Steel wire. 1.60, 1.95, 2,95. 4.00, 4,45mm dia
P.V.C coated wire 1.45,1.95 3.15, 4.00mm dia
Solid PVC Insulator

L···geometrical shade

Fig. 2. Arrongement of double conductor of different diameter

From the above characteristic curves, it can be found that the distribution of corona current is not analogic to the case of solar or lunar eclipse in astronomy. This is because the circular distribution of D. C. corona current is mostly influenced by the field intensity around the conductor surface. Due to particular electro static shielding effect in double conductor, corona current of surface discharge concentrically starts from the limited domain of small radial angle in conductor surface and also traces particular paths.

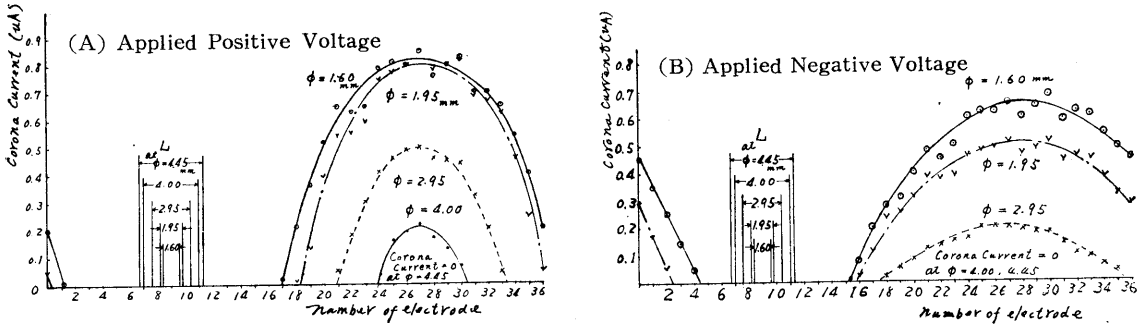


Fig. 3. Circular distribution curves of DC corona current from the double conductor of the following conbination

P···0.5mmϕ Brass Wire

Q···1.60, 1.95, 2.95, 4.00 and 4.45mmϕ, Steel Wire

Applied voltage···27kv const, x=5mm

The curves in Fig. 3 are drawn taking conductor diameter ϕ as a parameter. The corona current from the larger conductor is naturally smaller than that from the smaller conductor and consequently distribution curves of the conductor of smaller diameter have wide spread both in hight and width.

2-2 Circular Distribution of D. C. Corona current from Double Conductor of Brass Wire and PVC Coated wire.

In Fig. 4, brass wire of 0.5 mm diameter was used as conductor P and PVC coated wires of four different sizes, 4.00, 3.15, 1.95, 1.45 mm outside diameter were used as conductor Q. The

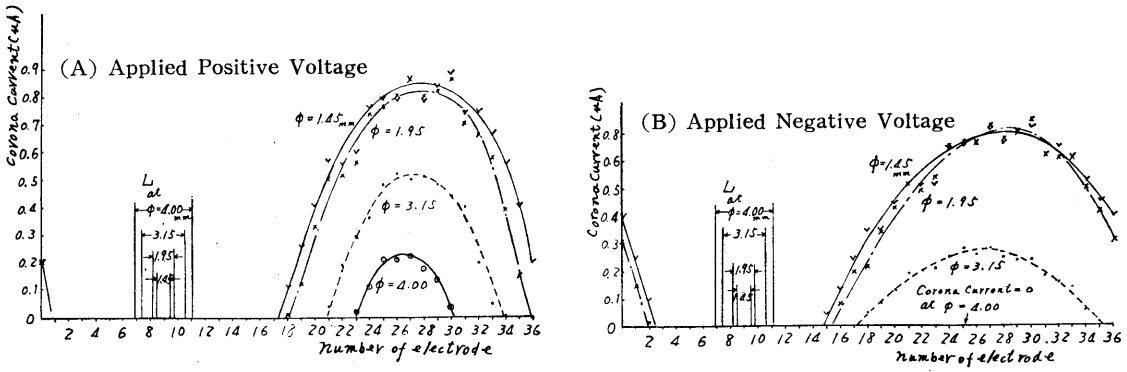


Fig. 4. Circular distribution curves of DC corona current from the double conductor of the following conbination
P···0.5mmϕ Brass Wire
Q···1.45, 1.95, 3.15, 4.00mmϕ PVC coated Wire
Applied voltage···27kV. const. x=5mm

characteristics in Fig. 4 do not show much differences from those in Fig. 3.

2-3 Combination of a Brass Wire and Solid PVC Insulator

In this case, the completely different circular distribution curves of corona current from the before-mentioned two cases were obtained. The corona current from brass electrode in Fig. 5 spreads in wider range and distribution curve of corona current was sharply convexed at the range of segments hidden by the insulator string.

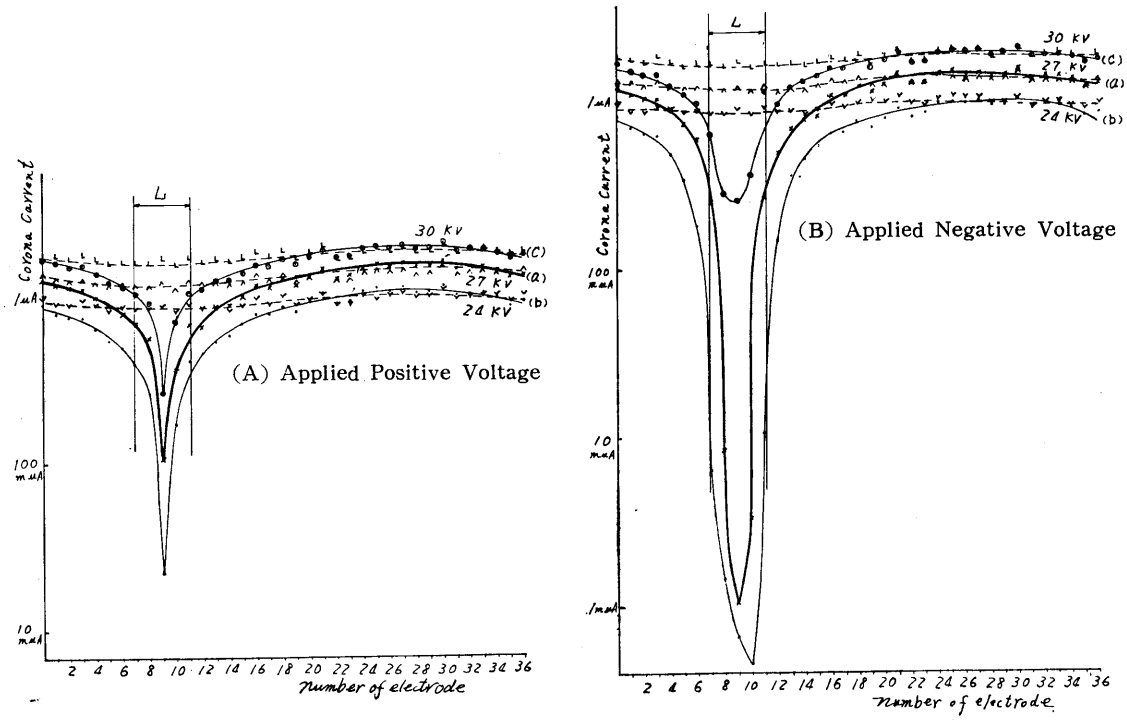


Fig. 5. Circular distribution curves of DC corona current from the double conductor from the following conbination.
P···0.5mmϕ Brass Wire
Q···4.0mmϕ String of solid PVC insulator
Applied voltage···24.27 and 30 kv. x 5mm

When the applied voltage was charged to 24kv or 30kv from 27kv, distribution curve (a) was

shifted to curve (b) or (c) in Fig. 5A and 5B respectively. After insulator string was taken out from the model, corona current distribution around the remaining conductor become nearly uniform and shifts parallel to the abscissa to the curves shown in dotted line in Fig. 5.

2-4 Discussion

In Fig. 6-A and 6-B, the results of the measurements with various conditions described in the above are summarized. Applied voltage was 27kv and spacing between two conductors was 5 mm.

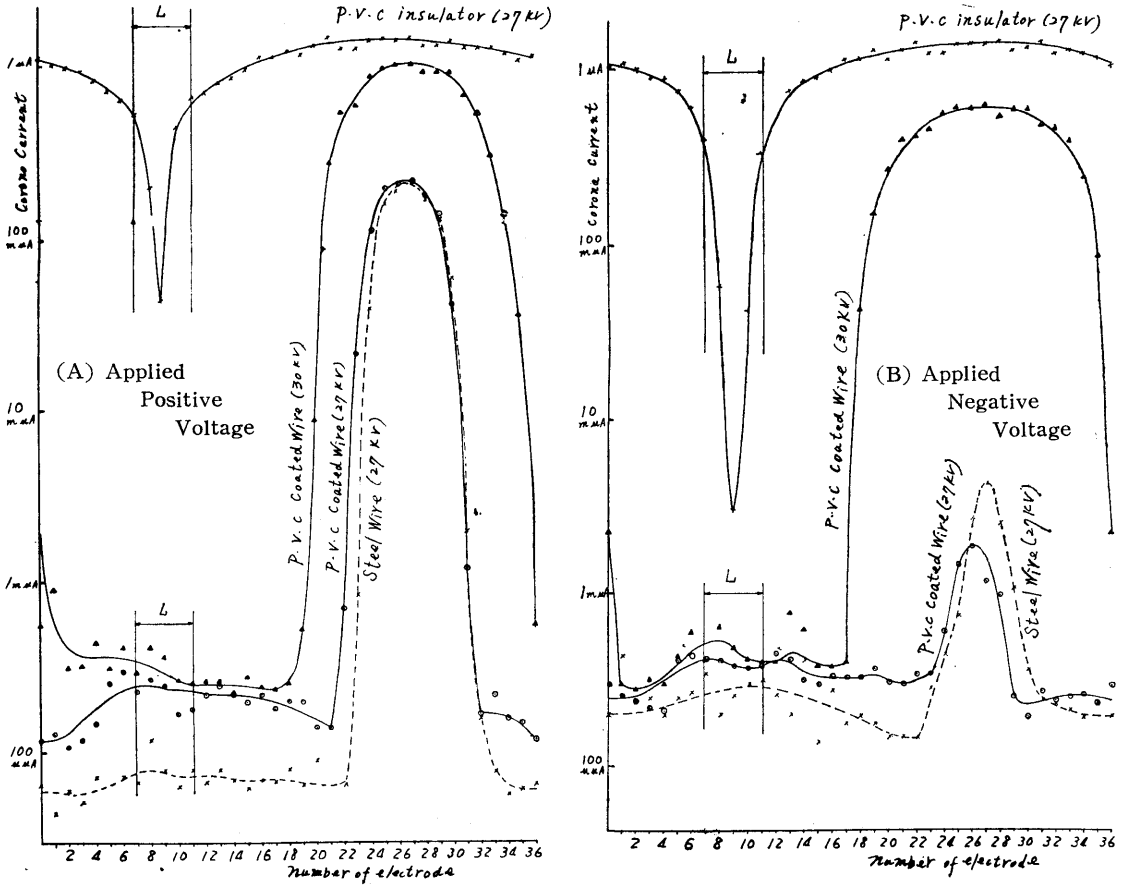


Fig. 6. Summarized results of circular distribution curves of corona current from the double conductor at various condition
P···0.5mmϕ Brass Wire
Q···4mmϕ Steel. P.V.C. coated wire and P.V.C. insulator.
Applied voltage···27kv, 30kv. x=5mm

In this case, micro-micro ammeter was used for the measurements of small corona current on the segment electrodes shaded by the larger conductor. From the results of Fig. 6, current on shaded segment electrodes ranges from 10^{-9} to 10^{-10}A. Thus, corona current values on the above two different parts are completely different and ratio between them is order of 10^3 to 10^1. In case of (2)-3, where a string of solid PVC insulator replaced one conductor, the shielding of double conductor in static field was not so much effective and the average value of corona current is much larger than those in the other two cases.

Figures 7-A and 7-B show the results of the above experiments in polar coordinates. Figures 7-A and 7-B give clear circular directionality of corona current on the double conductor and comparison between the distribution curves in the above three different cases.

(A) Applied Positive Voltage

(B) Applied Negative Voltage

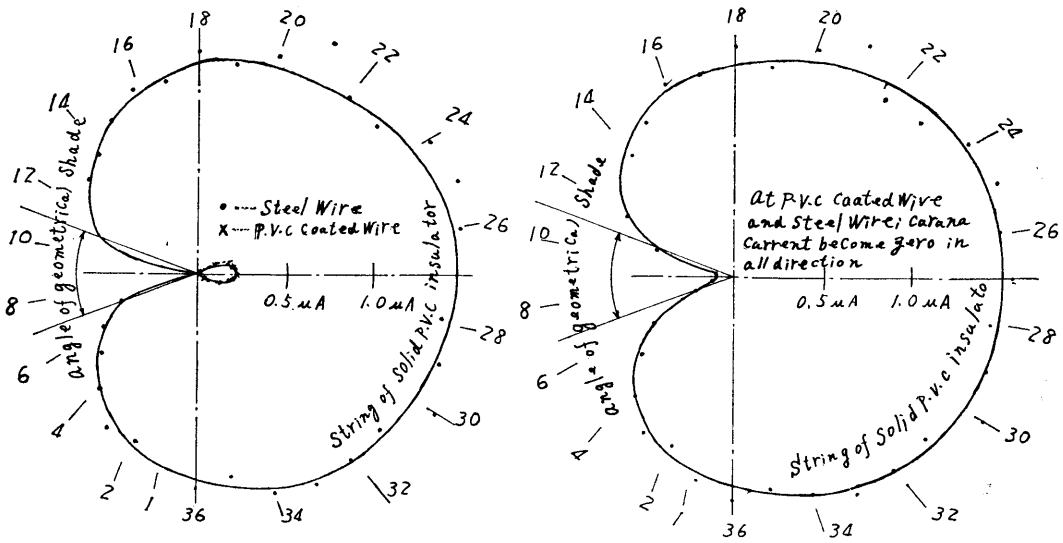


Fig. 7. Circular distribution curves of corona current in polar coordinates.
P···0.5mmϕ Brass Wire
Q···4mmϕ Steel wire, P.V.C coated wire, and P.V.C insulator.
Applied voltage···27kv x=5mm

Figure 8 show the relation between the angle of geometrical shade and the number of segments, be actually hidden by coductor Q, from corona current of conductor P.

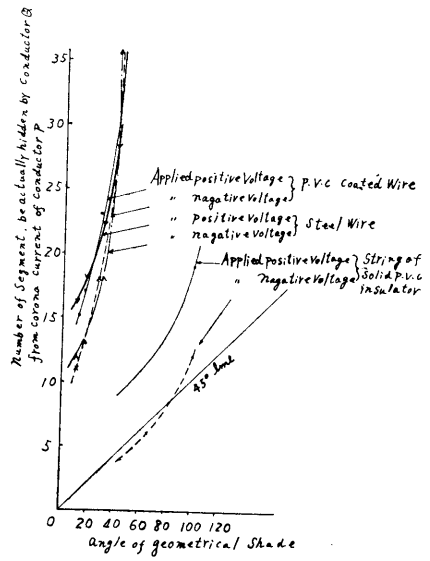


Fig. 8. Relation between the angle of geometrical shade and the number of segment, be actually hidden by conductor Q, from corona current of conductor P.

3. Conclusion

From the experimental results 2-(1), 2-(2) and 2-(3), it is concluded as follows:

(i) Circular distribution characteristics of corona current on double conductor, consisting of element conductors of different diameters, are asymmetrical curves and different from that of double conductor of same diameter. Corona currents are sharply localized in the domain limited by small circular angle due to particular shielding effect in static field of double conductor.

(ii) In case one of the double conductor is replaced by PVC coated wire of same diameter almost same distribution curves are obtained.

(iii) In case one of double conductor replaced by a string of solid insulator of same diameter, circular distribution characteristics become completely different. The insulator string in this case mostly acts as a barrier for the flow of corona current.

Reference

(1) S. Muto ; J. I. E. E of Japan 73 1102 (1953)

(2) S. Muto ; Bulletin of Nagoya Institute of Technology vol 12 253~258 (1963)