AN

INTRODUCTION TO ELECTRICITY

BY

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CHAPTER II

Distribution of electricity on an insulated conductor. How the full charge of a proof-ball can be transferred to the electroscope. Graduation of the electroscope. Analogy between the electroscope and the thermoscope. Aluminium electrometer. Graduation scale. Experiments with conical conductor. Variations of electric density on unequal surfaces. Constancy of the degree of electrification of an insulated conductor. Distribution of electric density on an insulated conductor in relation to the surface curvature. Action of points. Discharging power of a flame.

THE first day's journey has come to an end. A traveller, who wishes to fix in his mind the road which he has traversed, will do well, from time to time, to cast a glance behind him so as to note the windings of his path, and to impress upon his memory any particularly characteristic spots. Thus, as we wander through the still greatly unexplored domain of electricity, we will cast from time to time a glance behind, and pass in review before our mind's eye the most important phenomena observed.

We have just learned that: Retrospect.

(1) All bodies when rubbed or touched by "electric" (*i.e.*, electrified) bodies themselves become electric; but those which conduct must first be insulated, so that they may retain the electricity that they have received. The nature of the rubber has a very important bearing upon the strength of the electricity

produced by rubbing. The further apart rubber and rubbed are in the electrostatic tension series, the greater as a rule is this strength.

(2) If an electric conductor is connected to the earth, which is itself a conductor—as, for instance, by being touched by the hands—it will be discharged, *i.e.*, it will be made unelectric. If, on the other hand, the connecting wire be insulated, a part of the electric charge passes from the electrified body along the non-electric conductor, which itself becomes electric or charged by communication; if two bodies are charged with equal amounts of electricity, no electricity passes from one body to the other when they are brought into contact.

(3) There are only two distinct electrical states, and these are opposed to each other; for when a body is charged with equal quantities of +E and −E, they neutralize each other. The rubber and the thing rubbed have always opposite kinds of electricity. By friction, polished English flint-glass acquires *positive* electricity, and resin (or, better, soapstone) *negative* electricity. When an electrified body is slowly brought near a charged electroscope, and a further divergence of the leaves is caused, the body possesses the same kind of electricity as the electroscope; but the opposite kind, if the leaves fall together. Like kinds of electricity are repelled—unlike are attracted.

We will now ask ourselves the question, Where is the position or seat of electricity in an electrified body? Since, as we know, insulators do not conduct electricity, it is probable that the electricity will in their case remain where it was produced by friction or communicated by contact, *i.e.*, at the spot touched

If this supposition is right, the discharge of an electrified insulator can only happen when this spot is touched by the hand. We can soon convince ourselves of this by an experiment.

I charge an electroscope with an electrified flint-glass rod. At the approach of the rod the leaves diverge further, and indicate thereby that the rod is electrified. Then I cover the electrified surface of the rod with my hand, and you will see the part not in the immediate neighbourhood shows itself as still strongly electrified. Now I try, by grasping it in successive places, to discharge it, but I cannot quite succeed in doing so. To discharge it completely I must pass it through the flame of a spirit lamp,[1] or wave it backwards and forwards above it. This discharging power of the flame we will examine more carefully later on.

Where, then, is the seat of the electricity in, of course, an insulated conductor?

Here we see (A, fig. 9) a piece of fine-meshed pliant wire gauze, which is insulated by means of the ebonite stand (i). On both sides of this gauze movable strips of paper are fastened, those on one side being red, and on the other green. By means of the insulating handles (g_1 and g_2) I can bend the gauze as I like. Now I charge the gauze with the flint-glass rod by laying it on the upper edge of the net,

[1] Every flame free from soot will serve to discharge an insulator (*cf.* end of this chapter). As soot conducts electricity, a deposit of the same on bodies to be used as insulators must be carefully avoided; and the more so, because only the most thorough washing can remove it from surfaces that are at all rough. This washing should always be done when an insulator is to be entirely discharged. *Cf.* note 1, p. 83.

and then draw it along so that as much of the surface of the rod as possible may come into contact with this edge. You see how all the strips of paper are raised up, and, now that the gauze is straight, show equal divergence on both sides of it (B, fig. 9).

Seat of electricity in insulated conductor.

Now I ask you to fix your attention on the little red strips on your side of it. I grasp both insulated handles (g_1 and g_2) and bend the net—turning the hollow side towards you—gradually into the form of a hollow cylinder. You notice how the

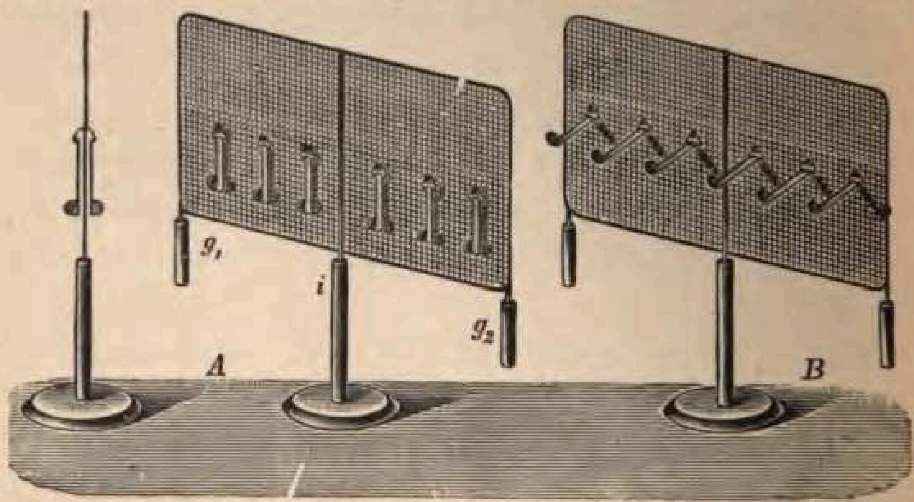

FIG. 9.—Vanderfliet's insulated wire gauze, with movable strips of paper, slightly modified, $\frac{1}{10}$ natural size.

little red leaves inside the hollow thus formed gradually sink, and—even before both edges of the gauze touch each other—fall entirely down (A, fig. 10), while the little green leaves outside show a considerably greater divergence than before. Now I bend the cylinder slowly back again: the red leaves gradually again raise themselves, while the green ones sink. When the gauze regains its flat condition the divergence of the red and green leaves is again the same (B, fig. 9). I bend the gauze more, so that the red leaves are on the convex side. You notice that they raise themselves still higher, while the green ones sink finally against the gauze. We gather from this, that when the gauze is held quite straight the electric charge is equally distributed on both sides of it; but as soon as it is bent the charge flows from the concave side to the convex or outer surface.

Thus, *the seat of the electric charge of an insulated conductor is its outer surface, and in the inside of an*

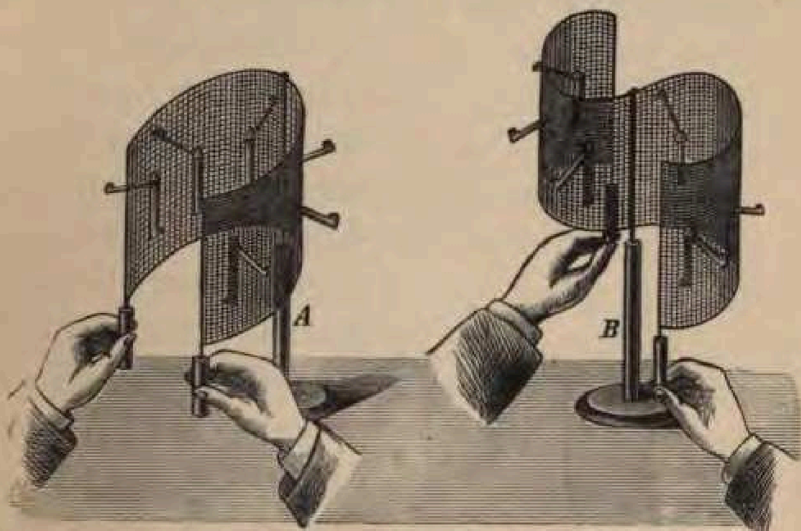

FIG. 10.—Demonstration of distribution of electricity.

almost closed hollow conductor there is evidently no electricity. This is a most important law.

When each side of the gauze is partly concave and partly convex, the electric charge must appear on both sides of it, but only on the convex parts. I give the net this form—and you see that this is actually the case (B, fig. 10). The middle of the gauze, where one curve merges into the other, forms the boundary of the electrification. This boundary is called the point of flexion.

Let us suppose that the electric charge of a body consists of very minute particles of electricity—this Lenz's explanation.