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PROTECTION FROM LIGHTNING.

The present season of thunderstorms brings the question of protection from lightning into special prominence. It is a matter in which every one is interested, for the electric fluid is no respecter of persons, and strikes both at the hut and the palace, while it does not always spare the lonely wayfarer plodding along the road far from buildings of all kinds. It is, however, high and isolated edifices that suffer from it most; churches, factories, farm-houses and country mansions are specially liable to its attacks. There are, however, now very few of these not furnished with conductors which are presumed to afford complete protection. Usually they do, but still it is by no means uncommon to hear of the lightning leaving a stout conductor to play vagaries within the building, springing hither and thither, and leaving most unpleasant footmarks wherever it alights. Until very recently it was customary to assume that the lightning conductor was in fault when such an unexpected result was realized. Either the joints were bad or the "earth" was deficient. Among rods of early date the latter was very often true, for they sometimes penetrated but a very short distance into the soil, or ended in a stratum which became perfectly dry during the hot months of summer. But when every allowance has been made for such imperfections in construction and erection, there still remain many cases of failure which are not easy to explain without recourse to researches which have been made public during the last few years, and which tend to weaken our faith in the theories regarding protection from lightning which were current only a very short time ago. When electric self-induction began to be studied by practical men, it was seen that it must have a great bearing on the conditions under which a flash of lightning can pass along a conductor. The question of a more or less perfect earth loses much of its importance in the face of a counter electromotive force of thousands of volts suddenly generated in the rod, and opposing the quiet passage of the lightning. It only lasts the minutest fraction of a second, but then lightning cannot brook any delay, and it will strike out from the rod in gushes at any place where a neighboring conductor offers it an alternative path, often traversing a foot or two of air, or piercing a brick wall in its attempt to escape. For purposes of analogy we may compare the effect of self-induction to that of inertia, to which it bears a great similarity. The rod is full of quiescent electricity, when suddenly the lightning starts from the clouds, and with one mad spring through half a mile of sky, it enters the conductor, seeking to rush through it to the ground. But to do this it must set in motion the electricity with which the rod is already filled. The effect is like a piston coming down on a mass of water in a steam cylinder; an enormous pressure is set up, and the fluid seeks every avenue of escape, spurting through joints and stuffing-box, and sometimes carrying the solid iron of the cylinder cover with it. In the same way the electricity will often dart out from the rod, even though the lower end may make most excellent contact with the soil. The self-induction in the conductor is too great to permit of the electromotive force of the discharge falling immediately to a safe limit; it is, no doubt, immensely decreased, for after a flash has traversed half a mile of sky a few feet of air is but a small matter.

The difficulty of getting an electric discharge to traverse a metallic conductor has been demonstrated by Dr. Oliver Lodge in a very simple but convincing manner. He takes two Leyden jars and connects their inner coats respectively to the two terminals of a Voss machine. Between the outer coats there are practically three paths along which electricity can travel, namely, the table on which they stand, an adjustable air gap between a pair of discharging balls, and an insulated wire. The table forms an imperfect conductor between the jars and the ground, while the insulated wire guarantees that the jars shall remain at the same potential. There are also a pair of adjustable discharging rods between the terminals of the machine. Now, when the machine is worked the electricity accumulates in the jars, and while it is doing so the outer coatings remain at the same potential, there being no current in the wire connecting them, and no tendency to spark at the air gap. The tension in the jars, however, rises until it is able to leap across the space between the terminals of the machine, whereupon there is an instant rush of electricity between the outer coatings. There is practically no path for it along the table, and hence, it must go along the conductor, or across the air gap, or by both paths. Now, as the resistance of air is millions of times greater than that of metal, we might, at first sight, assume that there could be no spark between the terminals. But Dr. Lodge shows that when the conductor consists of 40 ft. of No. 1 (B. W. G.) copper wire, the discharge will as easily leap across a space of 14·3 tenths of an inch as take the easy path open to it. The effect of the self-induction is to raise the natural resistance of the wire from ·025 ohms to something which is comparable with 1½ in. of air. If the copper wire be replaced by a similar length of thin iron wire (No. 27) having a resistance of 33·3 ohms, a still more unexpected