result is obtained. The resistance of the metallic circuit is now 1,300 times as great as before, but instead of the discharge being able to leap a wider gap, it can only bridge 10·3 tenths of an inch of air. If the continuous circuit be made through a capillary tube of liquid having a resistance of some 300,000 ohms, the spark length increases to 16 or 17 tenths.

We do not, however, need to employ even the very simple apparatus described above to demonstrate the tendency of an electric discharge to flash out sideways. If we take a yard of the thinnest platinum wire obtainable, and place it parallel to a thick copper rod, the ends of the wire being bent towards the rod until they approach it within a sixteenth of an inch, then, when the discharge from a Leyden jar is sent through the rod, it will be found that a part will leave it for the attenuated parallel path, leaping the air gap to reach it. The publication of Dr. Lodge's experiments has drawn attention to certain researches upon lightning discharges for protecting telegraph instruments carried out in 1864 by Professors Hughes and Guillemin. The results of the earlier trials are in substantial agreement with those of the later ones, except as regards the superiority of iron over copper as a conductor. It was found that no discharger would protect the coils of the instruments if a very powerful discharge from a large battery of Leyden jars was sent through it, and that if the discharger were replaced by a copper rod of 1 centimeter in diameter, sufficient electricity passed by way of the instruments to burn a fine iron wire. When, however, the wire was replaced by a flat plate, even of tinfoil, a very large measure of protection was obtained. We thus see that ordinary measurements of resistance applied to lightning conductors may be very misleading if other conditions are not taken into consideration.

When the existence and the effects of self-induction are appreciated it is easy to point out the means to minimize the latter. Clerk-Maxwell showed that "the electromotive force arising from the induction of a current on itself is different in different parts of the section of the wire, being in general a function of the distance from the axis of the wire as well as time." Professor Hughes has also experimentally investigated the comparative effect of disposing the metal of a conductor in different ways. He found that self-induction is reduced 80 per cent. in iron and 35 per cent. in copper by using the metal in the form of a flat strip or ribbon instead of in a cylindrical wire, and that if the ribbon were divided longitudinally into bands, and these were placed a little distance apart, the self-induction was still further reduced. He therefore recommended the use of copper strips for lightning rods. Dr. Lodge has also pursued the same line of investigations, using, however, the discharge from a Leyden jar, as more nearly resembling lightning than the interrupted currents of Professor Hughes. He proved, using the apparatus referred to above, that if a copper wire of given weight and length were employed to connect the jars, then when the air gap measured 8·36 millimeters the discharge would sometimes take place by the wire and sometimes through the air. If a ribbon conductor of the same weight and length were substituted for the wire then the air gap must be reduced to 6·25 millimeters before the same conditions were attained, thus showing that the ribbon presented an easier path for the discharge than the wire, although the metallic resistance of the two was equal. Dr. Lodge's experiments also seem to show that iron is quite as advantageous as copper as a material for lightning conductors, and he goes as far as to say that he considers the use of copper as doomed. It is well known that iron has far more self-induction than copper when tested in the ordinary way, and hence it offers a greater "impedance" to the passage of a current than the other metal. But when the discharge from a Leyden jar is substituted for the interrupted current then a result is obtained which suggests the explanation that the magnetic qualities of iron have not time to come into play during the passage of the discharge.

Now, in what way are the experimental data we have mentioned to be applied in practice? Shall we abandon our accustomed plan of seeing that the joints of the conductor are well and securely made, and cease to care whether the "earth" offers a great resistance or not? He would be a bold man, we think, who would venture to do this. The utility of the old plan has been proved in so many thousands of instances that it would be most foolish to abandon it on the strength of laboratory experiments. A Leyden jar is not a thunder cloud, and it is quite possible that its discharge does not exactly simulate the effects of lightning. But it would be equally unwise to neglect the latest teaching of science, for although lightning conductors generally serve the purpose for which they are designed, there is still a long list of unexplained failures which disturbs our faith in their efficiency. The safe course seems to be to graft the new principles on the old practice. Let us abandon the old cylindrical rod for the flat tape, or, better still, for a number of tapes or small wires led down different parts of the building, so that they may be beyond the sphere of each other's influence. Another point of importance is to provide plenty of electrostatic capacity for the reception of the flash, and thus to keep the electric tension moderate. Professors Hughes and Guillemin found that if they substituted a large condenser for their lightning discharger the result was far better. A splendid example of the protective power of an extensive metallic surface came to light in 1873, when the conductors of St. Paul's Cathedral were overhauled. It was found that the original conductors which had been erected for the protection of the dome had been cut through in the course of some alterations, and partly removed. The lead covering was absolutely insulated from the ground, and had been for some years. During that time it is certain that it must have been the recipient of many lightning flashes, yet it had never suffered any injury. It had taken them all in like the coating of a Leyden jar receives the output of a machine, and had held them until they leaked away down the wetted stonework, and thus gradually got away to earth. Unfortunately, leaden roofs are not very common in modern buildings, but where they exist they should be connected to the conductor at several points. This latter precaution is to avoid the destructive effects of the surging of the electricity which seems to take place after a flash, and it is of great importance. We have not, however, the space to enlarge on that point at present, but shall probably return to it in an early issue. For the present we must confine ourselves to the points mentioned above, with the addition of a caution against undue elevation of the point of a conductor. A lightning flash is too dangerous a visitor to be invited. Ample preparations must be made for its reception; but still its visit is not desirable, however hurried it may be.—*Electrical Engineer.*

THE DEADLY WIRE.

Recently an electric wire carrying a powerful current of the subtle and mysterious force fell across Bourbon Street, near the theatre of the French opera, at a time when many people were passing. It happened that a mule which was drawing a street car came in connection with this wire, and