WHAT ELECTRICIANS MEAN BY "EARTH."

By Sydney F. Walker.

Perhaps no science has a more puzzling nomenclature than electricity. Electrical engineers have named their units after the great men who have worked in their ranks, and by so doing have perpetuated the names of those men, as possibly nothing else could have done. But the names themselves, volts, ohms, amperes, farads, &c., are sad stumbling blocks to those who would like to know a little of the science, but who have not time to make a set study of it.

But of all terms used by electrical engineers, probably "earth" is the most puzzling.

Even the trained electrical engineer, the man who has spent a large portion of his life in the service of the science, has sometimes to think what is meant by "earth," in a particular case. How, then, can those who have not studied the subject follow its different meanings?

In the early days of electric science, before we knew anything like as much of it as we do now, and when its use was confined almost entirely to experiments shown in the laboratory, we had not these difficulties.

In those days "earth" meant earth, and nothing else. Electricity being looked upon then as something very much like water, only that it flowed in wires instead of pipes, it was natural to refer to mother earth as the great natural reservoir of electricity. As it is well known, you can always procure water if you dig down far enough in the earth, and the earth will always soak up or carry off, more or less readily, all the water that may descend on it. So, too, the early electricians found that by connecting one side of their frictional machines to earth—in this case the floor of the room—they could go on generating electricity as fast as it was discharged from the prime conductor. They found, too, that connection to earth in the form of their own person was fatal to a certain class of experiments.

Later on, also, when it was discovered that an electric current sent through a wire carried above the ground would return to the place of generation through the ground, the same idea prevailed. Old text books tell the student to regard a galvanic battery as an apparatus something like a pump drawing water from a well, able to draw an inexhaustible supply of electricity from the ground at one place, and to pour electricity into the ground, *ad infinitum*, at another place.

A study of old text books, and even some modern ones, will play rare havoc with the ideas held about 'earth' in connection with electric lighting supply, for instance.

In charging the electrophorus, for example, the student is told to put the brass plate to "earth;" to discharge it, in fact, by touching it with his finger. And the plate was, and is, so discharged. Fancy trying to discharge a 10,000 volt transformer in that way.

About the time of the advent of the telephone, it began to be realised that the part played by "earth" as a return for telegraph circuits was not exactly what it had been supposed. It was gradually recognized that the return current passed through the surface of the earth's crust, using what ever paths might be open to it, very much in the same way that the current passed in the wire forming the other portion of the circuit above ground. The only difference between them was that, while the locality of the current passing in the wire was fairly certain, that of the current passing through the ground was not so certain. A portion of the return current from Manchester to London, for instance, might go round by way of Glasgow or Aberdeen, if there happened to be a path for it by either of those routes.

The development of the telephone, with its often troublesome "cross talk," which was traced to earth connections, in a great measure gradually drove the old ideas of the reservoir quite out of the field. Especially was this so when it was reported from America that messages sent in one telephone wire had been heard on another telephone wire separated six miles from the first, the only possible connection being the earth's crust to which both wires were connected.

Gradually it came to be recognized by practical men that "earth" consisted of the conducting matter, such as moisture, mineral veins, &c., held in the earth's crust, with any metals buried there. But then came another trouble over this question of earth. How did "earth," affect a lightning discharge? and what was "earth" for a lightning rod? Surely the old idea held good here? Lightning came down the copper rod to "earth," and was discharged. Unfortunately, lightning does not always behave in this proper fashion. Prof. Oliver Lodge has rearranged our ideas upon this point. He has even maintained that the "earth" our forerunners worshipped is rather a drawback than otherwise. Some of us still believe in "earth" for lightning rods, though we prefer it of a different form usually to the old patterns; our views in the matter being based upon what we have learnt as to the use of the conductors in the earth's crust and in connection with other apparatus.

And, now, when we are congratulating ourselves upon having at last reached the dignity of supplying electric light from generating stations, just as gas has been supplied during the memory of the oldest of us, comes "earth" again, but it means something quite different, and yet the same.

Now, if a man standing on the ground touches an electric light wire carrying a high tension current, and receives a smart shock, he is said to have "earthed" the line, or the electric light service through his body. So, too, when a naked copper wire, used for delivering current to a series of arc lamps, touches an iron lamp-post, and thereby interferes with the working of the lamps beyond, it is said there is "earth" on. Again, when the possibility of users of electric light, who are supplied by high tension currents, getting shocks is discussed, we are shown various devices for putting the circuit to "earth," should such a contingency arise.

But in these cases the meaning of "earth," though sufficiently the same as in those previously noticed to warrant the retention of the name, is really quite different. "Earth" is not necessary in these cases, as it was in the early days of electricity, with frictional machines. Nor do we use "earth" to save us one cable, as we do with telegraph wires, and as we may with telephone wires.

It is true that in a recent lawsuit over some electric lighting patents "earth" was brought very much in evidence, but it was shown that what was meant was an uninsulated metallic return cable, and that the cable might be insulated if you like.

It is also true that certain electric tramways in America, and in this country, use what they call "earth" for their return current; but they do not mean "earth" in the old sense—they mean a set of conductors, the rails that happen to be on the ground. In electric lighting work we get as far away from "earth" as possible. To any but electrical engineers of considerable experience a recent report that has been made by a Board of Trade inspector must be exceedingly puzzling. Shocks were obtained from the water service in a house in St. James, and a gas meter had one of its sides, which rested against the damp wall, eaten through by electrolytic action. The water and gas service is referred to as being several volts above the conduit in which the cables of the Electricity Supply Company were laid; and further on it is stated in one part of the report that earth, which should be absolute zero of electrical potential, had a difference of 190 volts with one of the supply mains, the normal pressure of the service being 220 volts? What does all this mean? What does "earth" mean here?

In connection with electric light supply, where two insulated cables are used, "earth" may be taken to mean any conductor, such as water and gas pipes, iron conduits, &c., that may be present in the ground, and which are all more or less all in electrical connection with each other, by reason of the moisture which is held in suspension in the soil, as well as in bricks, wood, and even in the hardest stones present.

But, and here is the point where this "earth" varies from what we called "earth" before. These masses of metal, damp ground, &c., should have no connection with the electric lighting service at all; they are at absolute zero, because they are, or should be, absolutely neutral. Whenever they become connected, either directly or indirectly, with any portion of the electric lighting circuit, they are no longer at zero of electrical potential, because no longer neutral, and form part of the electric lighting system, just as if they had been regularly calculated for and laid as the cables were, and the danger, when such a connection exists, is not from any reservoir having been suddenly tapped, as a water-bearing fissure may be in a mine, but in the suddenly bringing within the influence of the electrical pressure created at the central station, of a system of conductors that are of uncertain and varying measurements, and quite beyond the control of the engineer.—*London Electrical News.*

SPARKS.

Mr. O. Higman, of Ottawa, has been appointed by the Dominion Government Inspector of Electric Lighting and is at present engaged in formulating rules for governing the installation and operation of electric plants.

At the Windsor Hotel, Ottawa, Ont., recently, the Mayor and a number of other notable men were invited to partake of a banquet, the components of which had been cooked to a nicety in an electrical oven, located at the car sheds, where the company afterwards had the pleasure of inspecting it. A local paper gives the following description of the cooking apparatus.—"The oven is of brick, about six feet wide, and somewhat deeper, and about six feet high In the lower part of the oven are two Ahearn heaters fed by a wire from the Chaudiere Electric Light Company, giving a power of fifty volts. There is no water about this system, as in the house heating. It is just the dry heat. The maximum warmth produced by the two heaters is literally sufficient to roast an ox so intense is it, but of course can be modified away down, and that easily. The beauty of the new system is that everything so cooked is done equally all through. There is no scorching in one part and half-done-ness in another part. To avoid loss of heat by opening and shutting of the oven door in cooking there are at the side of the doors peepholes, as it were, protected by heavy plate glass. The progress of cooking can thus be watched without disturbance to the articles being cooked."

With the assistance of the Provincial Secretary the town authorities have reached an agreement under which the Port Arthur electric railway will be extended to Fort William. The agreement provides that Fort William West will have a railway in full operation by next autumn. The whole length of the line will be eight miles, and a certain number of cars will run continuously from one end to another every day. Certain provisions were made as to Fort William taking a joint ownership if it so elects, and certain protective clauses were put in guarding Port Arthur's interests in the event of the portion of the road within the limits of Fort William being taken over by the municipality. Port Arthur is to have the right to run the road for 20 years from Dec. 1, 1893. At the end of that time Fort William may buy the property of the railway which lies within its own limits at a valuation to be settled by arbitrators. The railway plant and property are not to be taxed by the council of Fort William. Until Fort William pays for an interest in the road, the road is to be managed by the council of Port Arthur, who shall be entitled to the whole income derived from the railway. The line when completed will be a great boon to the citizens of Fort William and the large number of people who have occasion every summer to pass through that locality.