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AMERICA'S PART IN THE DISCOVERY OF MAGNETO-ELECTRICITY—A STUDY OF THE WORK OF FARADAY AND HENRY.—V.

BY

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FARADAY AND HENRY have asked the same question of Nature, and in the same way, and Nature has replied to each by the tremble of a needle and has confirmed her assertion by that beautiful thing, a spark. The great discovery of magneto-electricity is made. They were not conscious rivals, these two great men. Widely separated, each was simply intent upon finding out what Nature had to teach. If one had failed to make this gift to the world the other would have done so. We desire to make no ungracious comparison between them, yet it is but just to consider the position which each held in reference to the discovery. As Mont Blanc raises its snowy peak unchallenged above mountains of lesser but still great height, so Tyndall regards this achievement. Let us look at the two men in their relation to it, as they seem to stand before us, side by side.

1. As to advantage of circumstance. To scale the dizzy height, the advantage is with the mountaineer best equipped in experience, training and tools. If such advantage may be claimed in considering this discovery, let us look back and see again the different circumstances of the two men. Faraday, with nine years of advantage in age, has been at work in the Royal Institution of Great Britain for eighteen years, surrounded by every facility for study; with ample time at his command and under the instruction of one of the most eminent men of the age. Henry, in what was then a frontier town of a new country, with no other aid than his own earnest purpose, has had to snatch his days of investigation out of busy years filled with other matters; his only apparatus rude tools made by his own hands.

2. Faraday has been at work upon the subject since 1824; has tried it again and again "without result," although the phenomenon, unperceived by him, has been actually produced under his hands. Henry succeeds in his first attempt. Faraday has been, as it were, climbing for years the ascent, while Henry, at one spring, is at the top. Is this due only to the aid Henry's magnet has given both men? We cannot but feel, that under any circumstances, Henry's quick experimental instinct would not have been long in catching the moment when the gnome was at work. Look at the two men when the phenomenon is produced in the same way. Henry sees immediately that Nature's answer to his question is in the affirmative, and recognizes as immediately the proviso, namely: change or motion in the magnet. Faraday is not sure his fish is "not a weed;" tries again, to fail, as he could not have failed if he had understood what he saw; and not until he has made the experiment in another and entirely different way, is he sure of the phenomenon and recognizes its principle.

3. As to the means of the discovery, Henry's magnet. He had sent it over to Faraday in *Silliman's Journal*. He had made it for himself, out of his own brain and with his own hands. In making it he had made the stepping-stone for both; had made it easy for Nature to answer the question. We might almost say the magnet made the discovery. [This does not conflict with our assertion, that Faraday, using the magnet in the form of a ring, did not really make with it the discovery, but with a permanent magnet later. The ring showed him the phenomenon, and if he did not fully recognize this, led to his subsequent perception of it.]

4. As to priority: And now we come to the chief object of our story. It has been hitherto supposed that Faraday could claim this, but is it so? Certainly, on the score of publication. His first series of brilliant experiments was given to the world in November, 1831, while Henry's paper did not appear until July, 1832; but the world, advancing rapidly in every way, will soon no longer ask who was the first to *publish* but who was the first to *do*. Which of these men was the first actually to make this discovery?

Let us attend first to Henry's spoken statements. Sympathy is the gold of the heart, by means of which mind may win from mind its burden or its treasure. Quick to feel sympathetic interest in the concern of others, a like interest in his own affairs was a strong need in Henry's nature. Often by the fireside in his home he told to his wife and daughters the story of this great early disappointment; the story in facts as we have given it. How he made the discovery of the extra current five years before Faraday. How the discovery of magneto-electricity followed in 1830. How eager he was to pursue it, and how baffled by lack of time and materials. How he wished to amplify his results before he gave them to the world, and how he had commenced his great preparations for this purpose, and then, one day, in the library of the Academy, seizing eagerly upon a newly-arrived periodical, how he suddenly came upon the notice which told him that although he had made the discovery so long before any one else, Faraday must claim it. He might hurry his results into print but Faraday was there before him. "He who publishes first claims the discovery" was a code strictly held by Henry, and so he laid down all claim to the discovery, and in the years which followed in Princeton always attributed it in his lectures to Faraday. An old friend (Rev. Theodore L. Cuyler, D. D.), one of Henry's earliest pupils in Princeton, said recently to one of his daughters, "Your father often spoke to me of his disappointment about that discovery. 'I ought to have published earlier,' he used to say. 'I ought to have published but I had so little time. It was so hard to get things done. I desired to get out my results in good form and how could I know that another on the other side of the Atlantic was busy with the same thing?'"

Let us now study the evidence which lies under our eyes, in the published statements, and the one or two letters we have collected in this article, and see whether they corroborate our story. Bence Jones says that Faraday commenced experimenting the 29th of August, 1831, and that "the first experiment detailed in his note-book records the discovery." The experiment with the ring was made that day or the next, but the discovery, as we have shown, was

not really made until the 24th of September, when he first recognized positively the distinct conversion of magnetism into electricity. However this may be, *the 29th of August is the utmost limit for earliness to be claimed for Faraday.*

And now let us look at Henry's paper. We have given it entire, so that the reader may judge what it seems to say. It is published in July, 1832, but in its beginning it refers to last August, *that is August, 1831, the very August when Faraday is making his ring.* Henry says experiments were interrupted then, not to be resumed until "*the last few weeks,*" which we find from the latter part of the paper means "*the last two weeks in June*" (that is of 1832). A letter to Professor Silliman gives us the cause of this interruption, namely, that the room used by Henry was required for the opening of the Academy, and from another source we learn that the Academy opened the first of September. So this is the first thing we learn, that Henry is busy with the subject at the same time that Faraday is, in August, 1831, and that between that time and the last two weeks in June, there is an interval in which there are no experiments.

The second thing we learn from the paper is that in this interval, "*in the meantime,*" Henry says, comes a brief notice of Faraday's results dated April, 1832, and which Henry gives in the paper.

Now look again into the paper. It consists of a description of two series of experiments, *the one made before, the other after, seeing the notice of Faraday's result, dated April, 1832.* In the first series we find the great experiment. *If made before April, 1832, then before the close of August, 1831, the time when experiments stopped, and into the very last of those August days must we bring the experiment in order to give Faraday priority, the utmost limit of earliness for Faraday being the 29th of August.*

If our claim is just, that the discovery was not fully made by Faraday until the 24th of September, more than three weeks later than the last of August, the limit of lateness for Henry. Our point is proved here, but we desire to give every allowance to Faraday, so let us consider the ring experiment, the very earliest possible limit for Faraday.

This experiment was made the 29th and 30th of August, so there is but one day left, as we have said, into which we must squeeze Henry's experiment to give Faraday priority. It is not likely that Henry was at work on that last day; he had to give up his room to be cleaned, to remove his apparatus. But if at work, what is he doing? Not making this discovery—it has been already made. We are not left to conjecture; he tells us in his paper with what he is busy in those August days, "*making a great magnet and other preparations for a series of experiments with it on a large scale, in reference to the production of electricity by magnetism.*" We see exactly from the letters we have given, what he is doing when the cruel interruption comes; insulating with his own hands "*a mile of wire,*" "*bending a bar of iron weighing 101 lbs. into a horseshoe;*" and almost pathetic is the glimpse of the unfinished magnet, with all the labor it has entailed, in Henry's room in November, through the letter to Professor Cleaveland. Uncompleted is it still, when the following June comes and the experiments are resumed on a smaller scale. Henry does not say in his paper when in August the magnet was commenced, but considerable time must have been consumed in its construction before the 29th came. He had to stand over the workmen while they forged that bar weighing 101 lbs. He says in another letter to Professor Cleveland: "*I can get nothing done in the philosophical line in Albany except I stand over the workmen myself, or, which is most often the case, do the work myself.*" The insulating and winding of that reel of wire, a mile in length, alone represents an enormous amount of time to say nothing of the winding of the magnet. Of the labor entailed by the latter, we may have some idea from what he says of the magnet prepared for Professor Cleave-

land, in that letter of May 8, 1832. "*The winding of the wire was done with great care and under my constant inspection * * * * the process was a very tedious one and occupied myself and two other persons every evening for two weeks.*" On this particular magnet was wound 1,000 feet of wire, and Henry's unfinished one was larger, while "*the reel of wire a mile long*" was as carefully prepared. Henry must have been at work from early in the month, on these preparations for his extensive series of experiments when that memorable 29th of August came, and so we drive back the initial experiment *made before these preparations were begun,* to pursue the subject on a large scale. But it matters not for our present purpose whether this experiment was made days, weeks or months before that 29th of August, since it was before, to give Henry priority.

And so again is our point proved, since on the only day into which we must force Henry's experiment in order to give Faraday priority, Henry is distinctly busy *about something else.*

Does the paper tell us anything else to throw light upon the date of the discovery? The magnet upon which it was made tells us something. Henry tells us in his paper that the galvanic magnet used was the one described in *Silliman's Journal* vol. xix.; the one he had made to sustain seven hundred pounds. The date of the paper in which it is described is January 1, 1831, and the magnet was made in 1830. Thus is fixed for us the limit of earliness for Henry, that is, 1830, but there is something more in the use of this magnet. It suggests the probability that in this year 1830 the experiment we are in search of was made, because in January, 1831, was constructed the great magnet for New Haven, which remained in Henry's laboratory until spring came to break up the ice in the Hudson and allow it to be taken to its destination. With this more powerful, more complete magnet, in his possession, it is natural to suppose Henry would use this to ask the important question, rather than the earlier and inferior one, unless the experiment had been made before the construction of the larger one.

ISOLATED ELECTRIC LIGHTING WITH LOW-TENSION ALTERNATORS.

BY

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For the last thirteen years there has been little improvement in the methods of isolated electric lighting. The direct current dynamo has undergone some changes. It was very soon recognized that the series wound machine was unsuited to incandescent lamps in consequence of its want of regulating qualities. The shunt machine was then brought out and partially remedied this want and very soon after the two systems were compounded. It then took several years to finally perfect this principle and to achieve the excellent regulation we have to-day in this class of machines. Since then improvements in detail have been made and the insulation of the whole system has been improved. The armatures of dynamos are no longer driven at some thousands of revolutions a minute and the magnetic circuit has been greatly shortened and augmented in area.

The great nuisance of the commutator has not yet been lessened in incandescent light dynamos except in so far as the speed has been reduced and it still remains an evil; the more especially as these isolated plants are mostly under the care of an engineer who rarely acquires the knack of taking care of it. The lamps themselves are infinitely more durable than they were.

Are lamps two in series and with a resistance inserted,