

MICHAEL FARADAY

by

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SECTION I

THE STORY OF HIS LIFE

AT the beginning of this century, in the neighborhood of Manchester Square, London, there was an inquisitive boy running about, playing at marbles, and minding his baby-sister. He lived in Jacob's Well Mews, close by, and was learning the three R's at a common day-school. Few passers-by would have noticed him, and none certainly would have imagined that this boy, as he grew up, was to achieve the truest success in life, and to die honored by the great, the wise, and the good. Yet so it was; and to tell the story of his life, to trace the sources of this success, and to depict some of the noble results of his work, are the objects of this biographical sketch. It was not at Jacob's Well Mews, but in Newington Butts, that the boy had been born, on September 22, 1791, and his parents, James and , Margaret Faraday, had given this, their third child, the unusual name of Michael. The father was a journeyman blacksmith, and, in spite of poverty and feeble health, he strove to bring up his children in habits of industry and the love of God. Of course young Michael must soon do some- thing for his living. There happened to be a bookseller's shop in Blandford Street, a few doors from the entrance to the Mews, kept by a Mr. Riebau, an intelligent man, who is said to have had a leaning to astrology; and there he went as errand-boy when thirteen-years old. Many a weary walk he had, carrying round newspapers to his master's customers; but he did his, work faithfully; and so, after a twelvemonth, the book- seller was willing to take him as an apprentice, and that without a premium. Now a boy in a bookseller's shop can look at the inside as

numbering and describing the different experiments that he saw performed, and making wonderfully neat drawings of the apparatus, in good perspective. These notes he bound in four volumes, adding to each a copious index, and prefixing to the first this dedication to his master:

"To MR. G. RIEBAU. "

SIR,

-When first I evinced a predilection for the sciences, but more particularly for that one denominated electricity, you kindly interested yourself in the progress I made in the knowledge of facts relating to the different theories in existence, readily permitting me to examine those books in your possession that were in any way related to the subjects then occupying my attention. To you, therefore, is to be attributed the rise and existence of that small portion of knowledge relating to the sciences which I possess, and accordingly to you are due my acknowledgments. "Unused to the arts of flattery, I can only express my obligations in a plain but sincere way. Permit me, therefore, sir, to return thanks in this manner for the many favors I have received at your hands and by your means, and believe me your grateful and obedient servant,

"M. FARADAY."

Now there happen to be lodging at Mr. Riebau's a notable foreigner of the name of Masquerier. He was a distinguished artist, who had painted Napoleon's portrait, and had passed through the stirring events of the first French Revolution, not without serious personal danger, and was now finding a refuge and a home in London. He was struck with the intelligence of the apprentice, whose duty it was to do various offices for him; and he lent the young man his books, and taught him how to make the drawings in perspective which have already been alluded to. But the lectures in Dorset Street were not the only ones that Michael Faraday attended; and as the Royal Institution is the central scene of all his subsequent history, we must pay a mental visit to that building. Turning from the busy stream of Piccadilly into the quiet of Albemarle Street, we see, in a line with the other houses, a large Grecian facade with fourteen lofty pilasters. Between these are folding doors, which are pushed open

scientifiques qui lui ont été prodigués à juste titre, il a constamment refusé toutes les autres distinctions et les récompenses qu'on eût voulu lui décerner. Il s'est contenté toute sa vie de la position relativement modeste qu'il occupait à l'Institution Royale de Londres; avoir son laboratoire et strictement de quoi vivre, c'est tout ce qu'il lui fallait,- Presinge, le 29 août, 1867.

A. DE LA RIVE."

8. I am indebted to Sir Charles Wheatstone for the following impromptu by Herbert Mayo:

"Around the magnet Faraday
Was sure that Volta's lightnings play:
But how to draw them from the wire?
He drew a lesson from the heart:
'Tis when we meet, 'tis when we part,
Breaks forth the electric fire."

9. The room with glass sides, from which the light is exhibited at the top of a light-house, is called by this name.

10. One night there was a beautiful aurora. Mr. Holmes remarked that his poor electric light could not compare with that for beauty; but Faraday rejoined, "Don't abuse your light. The aurora is very beautiful, and so is a wild horse, but you have tamed it and made it valuable."

11. The illuminating apparatus at Dungeness is one of what is termed the sixth order, 300 millimetres (about 12 inches) in diameter. Mr. Chance constructed one for Souter Point. of the third order, one metre (nearly 40 inches) in diameter, with special arrangements for giving artificial divergence to the beam in a vertical direction, in order to obviate the danger arising from the luminous point not being always precisely in the same spot. It has also additional contrivances for utilizing the back light. Similar arrangements have been made for the South Foreland lights, which are also of the third order; and every portion of the machinery and apparatus is in duplicate in case of accident, and the double force can be employed in times of fog.

Institution, took young Faraday to hear the last four public lectures of Davy. The eager student sat in the gallery, just over the clock, and took copious notes of the professor's explanations of radiant matter, chlorine, simple inflammables, and metals, while he watched the experiments that were performed. Afterward he wrote the lectures fairly out in a quarto volume, that is. still preserved—first the theoretical portions, then the experiments with drawings, and finally an index. "The desire to be engaged in scientific occupation, even though of the lowest kind, induced me," he says, "while an apprentice, to write, in my ignorance 'of the world and simplicity of my mind, to Sir Joseph Banks, then President of the Royal Society. Naturally enough, , No answer was the reply left with the porter." On the 7th of October his apprenticeship expired, and on the next day he became a journey- man bookbinder under a disagreeable master, who, like his friend the artist, was a French emigre. No wonder he sighed still more for congenial occupation. Toward the end of that same October Sir Humphry Davy was working on a new liquid which was violently explosive, now known as chloride of nitrogen, and he met with an accident that seriously injured his eye, and produced an attack of inflammation. Of course, for a while he could not write, and, probably through the introduction of M. Masquerier, 2 the young book- seller was employed as his amanuensis. This, however, Faraday himself tells us lasted only "some days;" and in writing years afterward to Dr. Paris, he says, "My desire to escape from trade, which I thought vicious and selfish, and to enter into the service of Science, which I imagined made its pursuers amiable and liberal, induced me at last to take the bold and simple step of writing to Sir H. Davy, expressing .my wishes, and a hope that, if an opportunity came in his way, he would favor my views; at the same time I sent the notes I had taken of his lectures." Davy, it seems, called with the letter on one of his friends—at that time honorary inspector of the models and apparatus—and said; "Pepys, what am I to do? Here is a letter from a young man named Faraday; he has been attending my lectures, and wants me to give him employment at the Royal Institution—what can I do?" "Do ?" replied Pepys; "put him to wash bottles: if he is good for any thing, he will do it directly; if he refuses, he is good for nothing." "No, no," replied Davy, "we must try him with something better than that." So Davy wrote a kind reply, and had an interview with the young man upon the subject, in which, however, he advised him to stick to his business, telling him that "Science was a harsh mistress, and, in a pecuniary point of view, but poorly rewarding those who devoted

1. "Mittheilungen aus dem Reisetagebuche eines deutschen Naturforschers," p. 275.
2. Punch's cartoon next week represented Professor Faraday holding his nose, and presenting his card to Father Thames, who rises out of the unsavory ooze.
3. Since writing the above, I have come across a letter written by Faraday in answer to one by Captain Weller as far back as 13th Sept., 1839, in which he pointed out the maladjustment 1) of the dioptric apparatus at Orfordness. In July of the following year he made lengthy suggestions to the Trinity House, in which he proposed using a flat white circle or square, half an inch across, on a piece of black paper or card, as a "focal object." This was to be looked at from outside, in order to test the regularity of the glass apparatus. He also suggested observations on the divergence by looking at this white circle at a distance of twenty feet at most. Another plan he proposed was that of lighting the lamp and putting up a white screen outside. These methods of examining he carried out very shortly afterward at Blackwall, on " French and English refractors, but it seems never to have occurred to him to place his eye in the focus, or in any other manner to observe the course of the rays from inside the apparatus.
4. Dr. Scoffern, Belgravia, October, 1867.
5. A good instance of his caution in drawing conclusions is contained in one of his letters to me :

"ROYAL INSTITUTION OF GREAT BRITAIN, 2d July, 1859.

"My DEAR GLADSTONE, -Although :I have frequently observed lights from the sea, the only thing I have learned in relation to their relative brilliancy is that the 'average of a very great number of observations would be required for the attainment of a moderate approximation to truth. One has to be some miles off at sea, or else the observation is not

the next day, when subjected to the same treatment, it exploded with a fearful noise, and Sir Humphry was cut about the chin, and was struck with violence on the forehead. This seems to have put an end to the experiments. Nevertheless, in spite of disagreeables and dangers, the embryo philosopher worked on with a joyful heart, beguiling himself occasionally with a song, and in the evening playing tunes on his lute. The change in Michael Faraday's employment naturally made him more earnest still in the pursuit of knowledge. He was admitted as a member of the "City Philosophical Society," a fraternity of thirty or forty men in the middle or lower ranks of life, who met every Wednesday convening for mutual instruction; and here is a contemporary picture of him at one of its debates:

"But hark! A voice arises near the chair!
Its liquid sounds glide smoothly through the air;
The listening muse with rapture bends to view
The place of speaking, and the speaker too.
Neat was the youth in dress, in person plain;
His eye read thus, Philosopher in grain;
Of understanding clear, reflection deep;
Expert to apprehend, and strong to keep.
His watchful mind no subject can elude,
Nor specious arts of sophists e'er delude;
His powers, unshackled, range from pole to pole: His mind from error free,
from guilt his soul. Warmth in his heart, good humor in his face,
A friend to mirth, but foe to vile grimace;
A temper candid, manners unassuming,
Always correct, yet always unassuming.
Such was the youth, the chief of all the band;
His name well known,
 Sir Humphry's right hand.
With manly ease toward the chair he bends,
With Watts's Logic at his finger-ends."

Another way in which he strove to educate himself is thus described in his own words: "During this spring Magrath and I established the mutual improvement plan, and met at my rooms up in the attics of the Royal Institution, or at Wood Street at his warehouse. It consisted, perhaps, of

knowledge." **10** The Elder Brethren then wished a further trial of six months, during which time the light was to be entirely under their own control. It was therefore again kindled on August 22, and the experiment happened soon to be exposed to a severe test, as one of the light-keepers, who had been accustomed to the arrangement of the lamps in the lantern, was suddenly removed, and another took his place without any previous instruction. This man thought the light sufficiently strong if he allowed the carbon points to touch, as the lamp then required no attendance whatever, and he could leave it in that way for hours together. On being remonstrated with, he said, "It is quite good enough." Notwithstanding such difficulties as these the experiment was considered satisfactory, but it was discontinued at the South Foreland, for the cliffs there are marked by a double light, and the electric spark was so much brighter than the oil flames in the other house, that there was no small danger of its being seen alone in thick weather, and thus fatally misleading some unfortunate vessel. After this Faraday made further observations, estimates of the expense, and experiments on the divergence of the beam, while Mr. Holmes worked away at Northfleet perfecting his apparatus, and the authorities debated whether it was to be exhibited again at the Start, which is a revolving light, or at Dungeness, which is fixed. The scientific adviser was in favor of the Start; but, after an interview with Mr. Milner Gibson, then President of the Board of Trade, Dungeness was determined on; a beautiful small combination of lenses and prisms was made expressly for it by Messrs. Chance, and last, after two years' delay, the light again shone on our southern coast. It may be well to describe the apparatus. There are 120 permanent magnets, weighing about 50 lbs. each, ranged on the periphery of two large wheels. A steam-engine of about three-horse power causes a series of 180 soft iron cores, surrounded by coils of wire, to rotate past the magnets. This calls the power into action, and the small streams of electricity are all collected together, and by what is called a "commutator" the alternate positive and negative currents are brought into one direction. The whole power is then conveyed by a thick wire from the engine-house to the light-house tower, and up into the centre of the glass apparatus. There it passes between two charcoal points, and produces an intensely brilliant continuous spark. At sunset the machine is started, making about 100 revolutions per minute; and the attendant has only to draw two bolts in the lamp, when the power thus spun in the engine-room bursts into light of full intensity. The "lamp" regulates itself, so as to keep the points always at a proper

with the utmost readiness. We first went to Paris, and stopped there two months; afterward we passed, in a southerly direction, through France to Montpellier, on the borders of the Mediterranean. From thence we went to Nice, stopping a day or two at Aix on our way; and from Nice we crossed the Alps to Turin, in Piedmont. From Turin we proceeded to Genoa, which place we left afterward in an open boat, and proceeded by sea toward Lerici. This place we reached after a very disagreeable passage, and not without apprehensions of being overset by the way. As there was nothing there very enticing, we continued our route to Florence, and, after a stay of three weeks or a month, left that fine city, and in four days arrived here at Rome. Being now in the midst of things curious and interesting, something arises every day which calls for attention and observations. The relics of ancient Roman magnificence, the grandeur of the churches, and their richness also the difference of habits and customs, each in turn engages the mind, and keeps it continually employed. Florence, too, was not destitute of its attractions for me, and in the Academy del Cimento and the museum attached to it is contained an inexhaustible fund of entertainment and improvement; indeed, during the whole journey, new and instructive things have been continually presented to me. Tell B. I have crossed the Alps and the Apennines; I have been at the Jardin des Plantes; at the museum arranged by Buffon; at the Louvre, among the chefs d'oeuvre of sculpture and the masterpieces of painting; at the Luxembourg Palace, among Rubens's works; that I have seen a GLOWWORM!! water-spouts, torpedo, the museum at the Academy del Cimento, as well as St. Peter's, and some of the antiquities here, and a vast variety of things far too numerous to enumerate." But he kept a lengthy journal, and as we turn over the pages—for the best part of it is printed by Bence Jones—we meet vivid sketches of the provokingly slow custom-house officers, the postilion in jack-boots, and the thin pigs of Morlaix—pictures of Paris, too, when every Frenchman was to him an unintelligible enemy; when the Apollo Belvidere, the Venus de Medici, and the Dying Gladiator were at the Louvre, and ; when the First Napoleon visited the Senate in full state. "He was sitting in one corner of his carriage, covered and almost hidden from sight by an enormous robe of ermine, and his face overshadowed by a tremendous plume of feathers that descended from a velvet hat." We watch Sir Humphry as Ampere and others bring to him the first specimens of iodine, and he makes experiments with his traveling apparatus on the dark lustrous crystals and their violet vapor; we seem, too, to be present with the great English

Paris for producing combustible gas by the decomposition of water. The scheme failed, but a Mr. F. H. Holmes suggested that these expensive toys might be turned to account for the production of light. "My propositions," he told the Royal Commissioners of Light-houses, "were entirely ridiculed, and the consequence was, that instead of saying that I thought I could do it, I promised to do it by a certain day.' On that day, with one of Duboscq's regulators or lamps, I produced the magneto-electric light for the first time;—but as the machines were ill constructed for the purpose, and as I had considerable difficulty to make even a temporary adjustment to produce a fitting current, the light could only be exhibited for a few minutes at a time." He turned his attention to the reconstruction of the machines, and after carrying on his experiments in Belgium, he applied to the Trinity Board in February, 1857. Here was the tiny spark, which Faraday had produced just twenty-five years before, exalted into a magnificent star, and for Faraday it was reserved to decide whether this star should shed its brilliance from the cliffs of Albion. A good piece of optical apparatus, intended for the Bishop Rock in the Scillies, happened to be at the experimental station at Black-wall, and with this comparative experiments were made. We can imagine something of the interest with which Faraday watched the light from Woolwich, and asked questions of the inventor about all the details of its working and expense; and we can picture the alternations of hope and caution as he wrote in his report, "The light is so intense, so abundant, so concentrated and focal, so free from under-shadows (caused in the common lamp by the burner, so free from flickering, that one can not but desire it should succeed. But," he adds, "it would require very careful and progressive introduction,—men with peculiar knowledge and skill to attend it; and the means of instantly substituting one lamp for another in case of accident. The common lamp is so simple, both in principle and practice, that its liability to failure is very small. There is no doubt that the magneto-electric lamp involves a great number of circumstances tending to make its application more refined and delicate; but I would fain hope that none of these will prove a barrier to its introduction. Nevertheless, it must pass into practice only through the ordeal of a full, searching, and prolonged trial." This trial was made in the upper of the two light towers at the South Foreland; but it was not till the 8th of December, 1858, that the experiment was commenced. Faraday made observations on it for the first two days, but it did not act well, and was discontinued till March 28, 1859, when it again shot forth its powerful

manuscripts. But there came a change. Hitherto he had been absorbing; now he was to emit. The knowledge which had been a source of delight to himself must now overflow a~ a blessing to others, and ,this in two ways. His first lecture was given at the City Philosophical Society on January 17,1816, and in the same year his first paper was published in the Quarterly Journal of Science. The lecture was on the general properties of matter; the paper was an analysis of some native caustic lime from Tuscany. Neither was important in itself, but each resembled those little streams which travelers are taken to look at because they are the sources of mighty rivers, for Faraday became the prince of experimental lecturers, and his long series of published researches have won for him the highest niche in the temple of science. When he began to investigate for himself, it could not have been easy to separate his own work from that which he was expected to do for his master. Hence no small danger of misunderstandings and jealousies; and some of these ugly attendants on rising fame did actually throw their black shadows over the intercourse between the older and the younger man of genius. In these earlier years, however, all appears to have been bright; and the 'following letter, written from Rome in October, 1818, will give a good idea of the assistant's miscellaneous duties, and of the pleasant feelings of Davy toward him. It may be added that in another letter he is re- quested to send some dozens of " flies with pale bodies" to Florence, for Sir Humphry loved fly- fishing as well as philosophy.

"To M~. FARADAY.

"I received the note you were so good as to address to me at Venice; and by a letter from Mr. Hatchett I find that you have found the parallax of Mr. West's Sirius, and that, as I expected, he is mistaken. If, when you write to me, you will give the 3 per cents. and long annuities, it will be enough. "I will thank you to put the inclosed letters into the post, except those for Messrs. Morland and Messrs. Drummond, which perhaps you

other circumstances must be taken into account, such as their durability and their power of insulation-that is, preventing the leakage of the galvanic charge; but at least they show that one of the most abstruse discoveries of Faraday has penetrated already into our patent offices and manufactories. Two students in the Physical Laboratory at Glasgow have lately determined with great care the inductive capacity of paraffin, and there can be little doubt that the speculations of the philosopher as to the condition of a dielectric will result in rendering it still more easy than at present to send words of information or of friendly greeting to our cousins across the Atlantic or the Indian Ocean. The history of the magneto-electric light affords another remarkable instance of the way in which one of Faraday's most recondite discoveries bore fruit in his own lifetime; and it is the more interesting, as it fell to his own lot to assist in bringing the fruit to maturity.

"BRIGHTON, November 29, 1831.

"DEAR PHILLIPS,-For once in my life I am able to sit down and write to you without feeling that my time is so little that my letter must of necessity be a short one, and accordingly I have taken an extra large sheet of paper, intending to fill it with news. " But how are you getting on ? Are you comfortable ? And how does Mrs. Phillips do-and the girls? Bad correspondent as I am, I think you owe me a letter; and in the course of half an hour you will be doubly in my debt, pray write us, and let us know all. about you. Mrs. Faraday wishes me not to forget to put her kind remembrances to you and Mrs. Phillips in my letter... " We are here to refresh. I have been working and writing a paper that always knocks me up in health; but now I feel. well again, and able to pursue my subject; and now I will tell you what it is about. The title will be, I think, 'Experimental Researches in Electricity:'
I. On the Induction of Electric Currents; II. On the Evolution of Electricity from Magnetism;
III. On a new Electrical Condition of Matter;
IV. On Arago's Magnetic Phenomena. There is a bill of fare for you; and, what is more, I hope it will not disappoint you. Now the pith of all this I must give you very briefly; the demonstrations you shall have in the paper when printed.... "

So wrote Faraday to his intimate friend Richard Phillips, on November

strong mineral acids. Long, too, he tried to harden steel and prevent its rusting by alloying it with small quantities of platinum and the rarer metals; the boy blew the bellows till the crucibles melted, but a few ordinary razors seem to have been the best results. Far more successful was he in repeating and extending some experiments of Ampere on the mutual action of magnets and electric currents; and when, after months of work and many ingenious contrivances, the wire began to move round the magnet, and the magnet round the wire, he himself danced about the revolving metals, his face beaming with joy—a joy not unmixed with thankful pride—as he exclaimed, "There they go! there they go! we have succeeded at last." After this discovery he thought himself entitled to a treat, and proposed to his attendant a visit to the theatre. "Which shall it be?" "Oh, let it be Astley's, to see the horses." So to Astley's they went; but at the pit entrance there was a crush; a big fellow pressed roughly upon the lad, and Faraday, who could stand no injustice, ordered him to behave himself, and showed fight in defense of his young companion. The rising philosopher indulged, too, in other recreations. He had a wonderful velocipede, a progenitor of the modern bicycle, which often took him of an early morning to Hampstead Hill. There was also his flute; and a small party for the practice of vocal music once a week at a friend's house. He sang bass correctly, both as to time and tune. And though the City Philosophical Society was no more, the ardent group of students of nature who used to meet there were not wholly dispersed. They seem to have carried on their system of mutual improvement, and to have read the current scientific journals at Mr. Nicol's house till he married, and then alternately at those of Mr. R. H. Solly, Mr. Ainger, and Mr. Hennel, of Apothecaries' Hall, who came to a tragical end through an explosion of fulminating silver. Several of them, including Mr. Cornelius Varley joined the Society of Arts, which at that time had committees of various sciences, and was very democratic in its management; and, finding that by pulling together they had great influence, they constituted themselves a "caucus," adopting the American word, and meeting in private. Magrath was looked upon as a "chair-maker," and Faraday in subsequent years held the office of Chairman of the Committee of Chemistry, and occasionally he presided at the large meetings of the society. During this time (1823) the Athenaeum Club was started—not in the present Grecian palace in Pall Mall, but in a private house in Waterloo Place. Its members were the aristocracy of science, literature, and art, and they made Faraday their honorary secretary; but after a year he

the room. This principle could of course be applied to brackets or chandeliers else-where, but the professor made over any pecuniary benefit that might accrue from it to his brother, who was a lamp manufacturer, and had aided him in the invention. The achievements of Faraday are certainly not to be tested by a money standard, nor by their immediate adaptation to the necessities or conveniences of life. "Practical men" might be disposed to think slightly of the grand discoveries of the philosopher. Their ideas of utility" will probably be different. One man may take his wheat-corn and convert it into loaves of bread, while his neighbor appears to lose his labor by throwing the precious grain into the earth; but which is, after all, most productive? The loaves will at once feed the hungry, but the sower's toil will be crowned in process of time by waving harvests. Yet some of Faraday's most recondite inquiries did bear practical fruit even during his own lifetime. In proof of this, I will take one of his chemical and two of his electrical discoveries. Long ago there was a Portable Gas Company, which made oil gas and condensed it into a liquid. This liquid Faraday examined in 1824, and he found the most important constituent of it to be a light volatile oil, which he called bicarburet of hydrogen. The gas company, I presume, came to an end; but what of the volatile liquid? Obtained from coal-tar, and renamed Benzine or Benzol, it is now prepared on a large scale, and used as a solvent in some of our industrial arts. But other chemists have worked upon it, and, torturing it with nitric acid, they have produced nitrobenzol—a gift to the confectioner and the perfumer. And by attacking this with reducing agents there was called into existence the wondrous base aniline—wondrous indeed when we consider the transformations it underwent in the hands of Hofmann, and the light it was made to throw on the internal structure of organic compounds. Faraday used sometimes to pay a visit to the Royal College of Chemistry, and revel in watching these marvelous reactions. But aniline was of use to others besides the theoretical chemist. Tortured by fresh appliances, this base gave highly-colored bodies, which it was found possible to fix on cotton as well as woolen and silken fabrics, and thence sprang up a large and novel branch of industry, while our eyes were delighted with the rich hues of mauve and magenta, the Bleu de Paris, and various other "aniline dyes." Everyone who is at all acquainted with the habits of electricity knows that the most impassable of obstacles is the air, while iron bolts and bars only help it in its flight; yet, if an electrified body be brought near another body, with this invisible barrier between them, the electrical state of the second body is

intermarry, and are expected to "bear one another's burdens ;" so the Church has assumed the additional character of a large intertwined family and of a mutual benefit society. This rigid separation from the world, extending now through three or four generations, has produced a remarkable elevation of moral tone and refinement of manner; and it is said that no one unacquainted with the inner circle can conceive of the brotherly affection that reigns there, or the extent to which hospitality and material help is given without any ostentation, and received without any loss of self-respect. The body is rendered still more seclusive by demanding not merely unity of spirit among its members, but unanimity of opinion in every Church transaction. In order to secure this, any dissentient who persists in his opinion after repeated argument is rejected: the same is also the consequence of neglect of Church duties, as well as of any grave moral offense; and in such a community excommunication is a serious social ban, and though a penitent may be received back .once, he cat! never return a second time. It was in the midst of this little community that Faraday received his earliest religious impressions, and among them he found his ecclesiastical home till the day of his entrance into the Church above. Among the elders of the Sandemanian Church In London was Mr. Barnard, a silversmith of Paternoster Row. The young philosopher became a visitor at his house, and though he had previously written,

"What is't that comes in false, deceitful guise,
Making dull fools of those that fore were wise?
Tis Love, "

he altered his opinion in the presence of the citizen's third daughter, Sarah, and wrote to her what was certainly not the letter of a fool: "You know me as well or better than I do myself You know my former prejudices and my present thoughts-you know my weaknesses, my vanity, my whole mind; you have converted me from one erroneous way, let me hope you will attempt to correct what others are wrong. Again and again I attempt to say what I feel, but I can not. Let me, however, claim not to be the selfish being that wishes to bend your affections for his own sake only. In whatever way I can best minister to your happiness, either' by assiduity or by absence, it shall be done. Do not injure me by

Ericsson's caloric engine, Brunel's block machinery at Portsmouth, Petitjean's process for silvering mirrors, the prevention of dry-rot in timber, De la Rue's envelope machinery, artificial rubies, Bonelli's electric silk loom, Barry's mode of ventilating the House of Lords, and many kindred subjects. It may not be amiss to describe the last of his Friday evenings, in which he brought before the public Mr. C. W. Siemens's Regenerative Gas Furnace. The following letter to the inventor will tell the first steps:

"ROYAL INSTITUTION, March 22, .1862.

"My DEAR SIR,-I have just returned from Birmingham, and there saw at Chance's works the application of your furnaces to glass-making. I was very much struck with the whole matter. " As our managers want me to end the evenings here after Easter, have looked about for a thought, for I have none in myself I think I should like to speak of the effects I saw at - Chance's, if you do not object. If you assent, can you help me with any drawings or models,. or illustrations either in the way of thoughts or experiments? Do not say much about it out of doors as yet, for my mind is not settled in what way (if you assent) I shall present the subject.

"Ever truly yours,

M. FARADAY.

"C. W. SIEMENS, ESQ."

Of course the permission was gladly given, and Mr. Siemens met him at Birmingham, and for two days conducted him about works for flint and crown glass, or for enamel, as well. as about iron-works, in which his principle was adopted, f wondering at the professor's simplicity of character as well as at his ready power of grasping the whole idea. Then came the Friday evening, 20th of June, 1862, in which .he explained the great saving of heat effected, and pictured the world of flame into which he had gazed in some of those furnaces. But his powers of lecturing were enfeebled, and during the course of the hour he burnt his notes by accident, and at the conclusion he very pathetically bade his audience

books are still preserved, containing the minutes of the committee-meetings every Thursday after-noon, the Duke of Somerset chairman, and he secretary; also the record of the Friday evenings themselves, who lectured, and on what subject, and what was exhibited in the library, till June, 1840, when other arrangements were probably made. The year 1827 was otherwise fruitful in lectures: in the spring, a course of twelve on chemical manipulation at the London Institution; after Easter, his first course at Albemarle Street, six lectures on chemical philosophy (he had helped Professor Brande in 1824); **3** and at Christmas, his desire to convey knowledge, and his love to children, found expression in a course of six lectures to the boys and girls home for their holidays. These were a great success; indeed, he himself says they "were just what they ought to have been, both in matter and manner-but it would not answer to give an extended course in the same spirit." He continued these juvenile lectures during nineteen years. The notes for Courses of lectures were written in school copy-books, and sometimes he appends a general remark about the course, not always so favorable as the one given above. Thus he writes, "The eight lectures on the operations of the laboratory, April, 1828, were not to my mind." Of the course of twelve in the spring of 1827, he says he "found matter enough in the notes for at least seventeen." Up to 1833 Faraday was bringing the forces of nature in subjection to man on a salary of only £100 per annum, with house, coals, and candles, as the funds of the Institution would not at that time afford more; but among the sedate habitudes of the place was a tall, jovial gentleman, who lounged to the lectures in his old fashioned blue coat and brass buttons, gray smalls, and white stockings, who was a munificent friend in need. This was John Fuller, a member of Parliament. He founded a Professorship of Chemistry, with an endowment that brings in nearly £100 a year, and gave the first appointment to Faraday for life. When the Institution became richer, his income was increased; and when, on account of the infirmities of age, he could no longer investigate, lecture, or keep accounts, the managers insisted on his still retaining in name his official connection with the place, with his salary and his residence there. Nor, indeed, could they well have acted otherwise; for, though the Royal Institution afforded in the first instance a congenial soil for the budding powers of Faraday, his growth soon became its strength, and eventually the blooming of his genius, and the fruit it bore, were the ornament and glory of the Institution. It will be asked, Was this £100 or £200 per annum the sole income of Faraday? No; in early days he did commercial

deliberately make his calculation, give up the butter, and worship the goddess. For the same reason, also, he declined most of the positions of honor which he was invited to fill, believing that they would encroach too much on his time, though he willingly accepted the honorary degrees and scientific distinctions that were showered upon him.⁷ And among those who follow science lovingly there are two very distinct bands: there are the philosophers, the discoverers, men who persistently ask questions of Nature; and there are the practical men, who apply her answers to the various purposes of human life. Many noble names are inscribed in either bead-roll, but few are able to take rank in both services; indeed, the question of practical utility would terribly cramp the investigator, while the enjoyment of patient research in unexplored regions of knowledge is usually too ethereal for those who see their pleasure in useful inventions. The mental configuration is different in the two cases; each may claim and receive his due award of honor. Faraday was pre-eminently a discoverer; he liked the name of "philosopher." His favorite paths of study seem to wander far enough from the common abodes of human thought or the requirements of ordinary life. He became familiar, as no other man ever was, with the varied forces of magnetism and electricity, heat and light, gravitation and galvanism, chemical affinity and mechanical motion; but he did not seek to "harness the lightnings," or to chain those giants and make them grind like Samson in the prison-house. His way of treating them reminds us rather of the old fable of Proteus, who would transform himself into a whirlwind or a dragon, a flame of fire or a rushing stream, in order to elude his pursuer; but if the wary inquirer could catch him asleep in his cave, he might be constrained to utter all his secret knowledge; for the favorite thought of Faraday seems to have been that these various forces were the changing forms of a Proteus, and his great desire seems to have been to learn the secret of their origin and their transformations. Thus he loved to break down the walls of separation between different classes of phenomena, and his eye doubtless sparkled with delight when he saw what had always been looked upon as permanent gases liquefy like common vapors under the constraint of pressure and cold-when the wires that coiled round his magnets gave signs of an electric wave, or coruscated with sparks-when the electricities derived from the friction machine and from the voltaic pile yielded him the same series of phenomena when he recognized the cumulative proof that the quantity of electricity in a galvanic battery is exactly proportional to the chemical action-when his electrostatic theory

that opinion. The position which I presume you would wish me to hold is analogous to that of a standing counsel." For nearly thirty years Faraday continued to report on all scientific suggestions and inventions connected with light-houses or buoys, not for personal gain or renown, but for the public good. His position was never above that of a "standing counsel." In his own words, "I do not know the exact relation of the Board of Trade and the Trinity House to each other; I am simply an adviser upon philosophical questions, and am put into action only when called upon." In regard to the lectureship at Woolwich, Mr. Abel, his successor, writes thus: "Faraday appears to have enjoyed his weekly trips to Woolwich, which he continued for so many years, as a source of relaxation. He was in the habit of going to Wool which in the afternoon or evening preceding his lecture at the Military Academy, then preparing at once for his experiments, and afterward generally taking a country ramble. The lecture was delivered early the following morning. No man was so respected, admired, and beloved as a teacher at the Military Academy in former days as Faraday. Many are the little incidents which have been communicated to me by his pupils illustrative of his charms as a lecturer, and of his kindly feelings for the youths to whom he endeavored to impart a taste for, if not a knowledge of, science. But for some not ill-meant, though scarcely judicious proposal to dictate modifications in his course of instruction, Faraday would probably have continued for some years longer to lecture at Woolwich. In May, 1852, soon after I had been appointed his successor, Faraday wrote to me requesting the return of some tubes of condensed gases which he left at the Academy. This letter ends thus: 'I hope you feel yourself happy and comfortable in your arrangements at the Academy, and have cause to be pleased with the change. I was ever very kindly received there, and that portion of regret which one must ever feel in concluding a long engagement would be in some degree lessened with me by hearing that you had reason to be satisfied with your duties and their acceptance. Ever very truly yours, M. FARADAY.'"

For year after year the life of Faraday afforded no adventure and little variety, only an ever-growing skill in his favorite pursuits, higher and higher success, and ever-widening fame. But, simple as were his mind and his habits, no one picture can present him as the complete man; we must try to make sketches from various points of view, and leave it to the

College, Cambridge, October 14, 1837, begins thus:

"My DEAR SIR,-I am always glad to hear of the progress of your researches, and never the less so because they require the fabrication of a new word or two. Such a coinage has always taken place at the great epochs of discovery, like the medals that are struck at the beginning of a new reign, or rather like the change of currency I produced by the accession of a new sovereign, for their value and influence consists in their coming into common circulation."

* * * * *

During the whole time of an investigation Faraday had kept ample notes, and when all was completed he had little to do but to copy these notes, condensing or rearranging some parts, and omitting what was useless. The paper then usually consisted of a series of numbered paragraphs, containing first a statement of the subject of inquiry, then a series of experiments giving negative results, and afterward the positive discoveries. In this form it was sent to the Royal Society or some other learned body. Yet this often involved considerable labor, as the following words written to Miss Moore in 1850 from a summer retreat in Upper Norwood will show: "I write, and write, and write, until nearly three papers for the Royal Society are nearly completed, and I hope that two of them will be good; if they, do justify my hopes, for I have to criticize them again and again before I let them loose. You shall hear of them at some of the next Friday evenings." This criticism did not cease with their publication, for he endeavored always to improve on his previous work. Thus, in 1832, he bound his papers together in one volume, and the introduction on the fly-leaf shows the object with which it was done: "Papers of mine, published in octavo, in the Quarterly Journal of Science and elsewhere, since the time that Sir H. Davy encouraged me to write the analysis of caustic lime. "Some, I think (at this date), are good, others moderate, and some bad. But I have put all into the volume, because of the utility they have been of to me-and none more than the bad- in pointing out to me in future, or rather after times, the faults it became me to watch and to avoid.

forward, and scarcely capable of keeping his fingers off the apparatus-not at all able if any thing seems to be going wrong; when the discourse is over, a warm shake of the hand, with "Thank you for a pleasant hour," and " Good -night" to those around him, and upstairs with his wife and some particularly congenial friends to supper. On the dining-table is abundance of good fare and good -wine, and around it flows a pleasant stream of lively and intellectual conversation. But suppose it is his own night to lecture. The subject has been carefully considered, an outline of his discourse has been written on a sheet of foolscap, with all the experiments marked and numbered, and during the morning everything has been arranged on the table in such order that his memory is assisted by it; the audience now pours in, and soon occupies all the seats, so that late comers must be content with sitting on the stairs, or standing in the gangways or at the back of the gallery. Faraday enters, and, placing himself in the centre of the horseshoe table, perfect master of himself, his apparatus, and his audience, commences a discourse which few that are present will ever forget. Here is a picture by Lady Pollock: "It was an irresistible eloquence, which compelled attention and insisted upon sympathy. It waked the young from their visions, and the old from their dreams. There was a gleaming in his eyes which no painter could copy, and which no poet could describe. Their radiance seemed to send a strange light into the very heart of his congregation; and when he spoke, it was felt that the stir of his voice and the fervor of his words could belong only to the owner of those kindling eyes. . His thought was rapid, and made itself a way in new phrases-if it found none ready made-as the mountaineer cuts steps in the most hazardous ascent with his own axe. His enthusiasm sometimes carried him to the point of ecstasy when he expatiated on the beauties of Nature, and when he lifted the veil from her deep mysteries. His body then took motion from his mind; his hair streamed out from his head; his hands were full of nervous action; his light, lithe body seemed to quiver with its eager life. His audience took fire with him, and every face was flushed. What- ever might be the after-thought or the after-pursuit, each hearer for the time shared his zeal and his delight." ⁷ Is it possible that he can be happier when lecturing to the juveniles? The front rows are filled with the young people; behind them are ranged older friends and many of his brother philosophers; and there is old Sir James South, who is quite deaf, poor man, but has come, as he says, because he likes to see the happy faces of the children. How perfect is the attention! Faraday, with a beaming countenance, begins with

would lead to further questions. Thus his work often consisted in the defeat of one hypothesis after another, till the true conditions of the phenomena came forth, and claimed the assent of the experimenter and ultimately of the scientific world. A.de la Rive has some acute observations on this subject. He explains how Faraday did not place himself before his apparatus, setting it to work, without a preconceived idea; neither did he take up known phenomena, as some scientific men do, and determine their numerical data, or study with great precision the laws which regulate them. A third method, very different from the preceding, is that which, quitting the beaten track, leads, as if by inspiration, to those great discoveries which open new horizons to science. This method, in order to be fertile, requires one condition-a condition, it is true, which is but rarely met with -namely, genius. Now this condition existed in Faraday. Endowed, as he himself perceived, with much imagination, he dared to advance where others would have recoiled: his 'sagacity, joined to an exquisite scientific tact, by furnishing him with a presentiment of the possible, prevented him from wandering into the fantastic; while, always wishing , only for facts, and accepting theories only with difficulty, he was nevertheless more or less directed by preconceived ideas, which, whether true or false, led him into new roads, where most frequently he found what he sought, and sometimes also what he did not seek, but where he constantly met, with some important discovery. "Such a method, if indeed it can be called one, although barren and even dangerous with mediocre minds, produced great things in Faraday's hands; thanks, as we have said, to his genius, but thanks also to that love of truth which characterized him, and which preserved him from the temptation so often experienced by every discoverer, 'of seeing what he wishes to see, and not' I seeing what he dreads." This love of truth deserves a moment's pause. It was one of the most beautiful and most essential of his characteristics; it taught him to be extremely cautious in receiving the statements , of others or in drawing his own conclusions, ⁵ and it led him, if his skepticism was overcome, to adopt at once the new view, and to maintain it indeed be, against the world. "The thing I am proudest of, Pealosal, is that I have never been found to be wrong," he could say in the early part of his scientific history without fear of contradiction. After his death A. de la Rive wrote, "I do not think that Faraday has once been, caught in a mistake, so precise and conscientious was his mode of experimenting and observing." This is not absolutely true; but the extreme rarity of his mistakes, notwithstanding the immense

texts, but the congregation does not see the card, only a little Bible in his hand, the pages of which he turns quickly over, as, fresh from an honest heart, there flows a discourse full of devout thought, clothed largely in the language of Scripture. After a loud simultaneous "Amen" has closed the service, the Church members withdraw to their common meal, the feast of charity; and in the afternoon there is another service, ending by invariable custom with the Lord's Supper. The family group do not reach home till half past 5; then there is a quiet evening, part of which is spent by Faraday at his desk, and they retire to rest at an early hour. Again on Wednesday evening he is among the little flock. The service is somewhat freer, for not the officers of the Church only, but the ordinary members, are encouraged to express whatever thoughts occur to them, so as to edify one another. At these times, Faraday, especially when he was not an elder, very often had some word of exhortation, and the warmth of his temperament would make itself felt, for he was known in the small community as an experimental rather than a doctrinal preacher. The notes of his more formal discourses which I have had the opportunity of seeing indicate, as might be expected from the tenets of his Church, a large acquaintance with the words of Scripture, but no knowledge of modern exegesis. They appear to have impressed different hearers in different ways. One who heard him frequently, and was strongly attached to him, says that his sermons were too parenthetical and rapid in their delivery, with little variety or attractiveness; but another scientific friend, who heard him occasionally, writes, "They struck me as resembling a mosaic work of texts. At first you could hardly understand their juxtaposition and relationship; but as the well-chosen pieces were filled in, by degrees their congruity and fitness became developed, and at last an amazing sense of the power and beauty of the whole filled one's thoughts at the close of the discourse." Among the latest of his sermons was one that he preached at Dundee about four years before his death. He began by telling his audience that his memory was failing, and he feared he could not quote Scripture with perfect accuracy; and then, as said one of the elders present, "his face shone like the face of an angel" as he poured forth the words of loving exhortation. When a mind is stretched in the same direction week-'day and Sunday, the tension is apt to become too great. With Faraday the first symptom was loss of memory. Then his devoted wife had to hurry him off to the country for rest of brain. Once he had to give up work almost entirely for a twelvemonth. During this time he traveled in Switzerland, and extracts from his diary are given by Bence

attention of all the light-house authorities to this fact, and asked the Elder Brethren of the Trinity House, with Faraday and other parties, to meet them at the lights recently erected at the North Foreland and Whitby. I, as the scientific member of the commission, had drawn I out in detail the course of rays from different parts of the flame, through different parts of the apparatus, and I was struck with the readiness with which Faraday, who had never before considered the matter, **3** took up the idea, and recognized its importance and its practical application. With his characteristic ingenuity, too, he devised a little piece of apparatus for the more exact observation of the matter inside the light-house. He took to Mr. Ladd, the optical instrument maker, a drawing, very neatly executed, with written directions, and a cork cut into proper shape, with two lucifer matches stuck through it, to serve as a further explanation of his meaning, and from this the "focimeter," as he called it, has made. The position of the glass panels at Whitby was corrected by means of this little instrument, and there were many journeys down to Chance's glass-works near Birmingham, where, declining the hospitality of the proprietor in order to be absolutely independent, he put up at a small hotel while he made his experiments, and jotted down his observations on the cards he habitually carried in his pocket. At length we were invited down to see the result. Faraday explained carefully all that had been done, and at the risk of seasickness (no trifling matter in his case) accompanied us out to sea to observe the effect from various directions and at various distances. The experience acquired at Whitby was applied elsewhere, and in May, 1801, the Trinity House appointed a Visiting Committee, "to examine all dioptric light establishments, with the view of remedying any inaccuracies of arrangement that may be found to exist." Faraday had instructed and practiced Captain Nisbet and some others of the Elder Brethren in the use of the focimeter, and now wrote a careful letter of suggestions on the question of adjustment between the lamp, and the lenses, and prisms; so thoughtfully did he work for the benefit of those who "go down to the sea in ships, that do business in great waters." As to the mental process that devised, directed, and interpreted his experiments, it must be borne in mind that Faraday was no mathematician; his power of appreciating and priori reason often appeared comparatively weak. "It has been stated on good authority that Faraday boasted on a certain occasion of having only once in the course of his life performed a mathematical calculation: that once was when he turned the handle of Babbage's calculating machine." **4** "Though there was more pleasantry

perhaps to witness the performance of some "Wizard of the North." . Now and then he would pay a visit to some scene of early days. One of his near relatives tells me: "It is said that Mr. Faraday once went to the shop where his father had formerly been employed as a blacksmith, and asked to be allowed to look over the place. When he got to a part of the premises at which there was an opening into the lower workshop, he stopped and said, 'I very nearly lost my life there once. I was playing in the upper room at pitching half- pence into a pint pot close by this hole, and having succeeded at a certain distance, I stepped back to try my fortune further off, forgetting the aperture, and down I fell; and if it had not been that my father was working over an anvil fixed just below, I should have fallen on it, broken my back, and probably killed myself. As it was, my father's back just saved mine.'" Business, as well as pleasure, sometimes took him away from home. He often joined the British Association, returning usually on Saturday, that he might be among his own people on the Lord's Day. During the meeting he would generally accept the hospitality of some friend; and it was one of these occasions that gave rise to the following jeu d'esprit:

"That P will change to F in the British tongue is true (Quoth Professor Phillips), though the instances are few:'
An entry in my journal then I ventured thus to parody,
'I this day dined with Phillips, where I hobbled and nobbed with Faraday.'

T. T.

"OXFORD, June 27, 1860."

At the Liverpool meeting in 1837 he was president of the Chemical Section, and on two other occasions he was selected to deliver the evening lecture, but, though repeatedly pressed to under-take the presidency of the whole body, he could not be prevailed upon to accept the office. My first personal intercourse with him, of any extent, was at the Ipswich meeting in 1851. I watched him with all the interest of an admiring disciple, and there is deeply engraven on my memory the vivacity of his conversation, the eagerness with which he entered into some mathematico-chemical speculations of Dumas, and the playfulness with which, when we were dining together, he cut boomerangs out of

his hand." I Nor did Faraday require elaborate apparatus to illustrate his meaning, Steaming up the Thames one July day in a penny boat, he was struck with the offensiveness of the water, He tore some white cards into pieces, wetted them so as to make them sink easily, and dropped them into the river at each pier they came to. Their sudden disappearance from sight, though the sun was shining brightly, was proof enough of the impurity of the stream; and he wrote a letter to the Times describing his observations, and calling public attention to the dangerous state of the river. ² At a meeting of the British Association he wished to explain the manner in which certain crystallized bodies place themselves between the poles of an electromagnet: two or three raw potatoes furnished the material out of which he cut admirable models of the crystals. Faraday's manner of experimenting may be further illustrated by the recollections of other friends who have had the opportunity of watching him at work. Mr. James Young, who was in the laboratory of University College in 1838, thus writes: "About that time Professor Graham had got from Paris Thilorier's apparatus for producing liquid and solid carbonic acid; hearing of this, Mr. Faraday came to Graham's laboratory, and, as one might expect, showed great interest in this apparatus, and asked Graham for the loan of it for a Friday evening lecture at the Royal Institution, which of course Graham readily granted, and Faraday asked me to come down to the Institution and give him the benefit of my experience in charging and working the apparatus; so I spent a long evening at the Royal Institution laboratory. There was no one present but Faraday, Anderson, and myself The principal thing we did was to charge the apparatus and work with the solid carbonic acid, Mr. Faraday working with great activity: his motions were wonderfully rapid; and if he had to cross the laboratory for any thing, he did not walk at an ordinary step, but ran for it, and when he wanted any thing he spoke quickly. Faraday had a theory at that time that all metals would become magnetic if their temperature were low enough; and he tried that evening some experiments with cobalt and manganese, which he cooled in a mixture of carbonic acid .and ether, but the results were negative." Among the deep mines of the Durham coal-field is one called the Haswell Colliery. One Saturday afternoon, while the men were at work in it as usual, a terrible explosion occurred: it proceeded from the fire-damp that collects in the vaulted space that is formed in old workings when the supporting pillars of coal are removed and the roof falls in: the suffocating gases rushed along the narrow passages, and overwhelmed ninety-five poor fellows with destruction. Of course there was an inquiry,

invariably declined dinner-parties, except at Lady Davy's, and at Mr. and Mrs. Masquerier's at Brighton, toward whom he felt under an obligation on account of former kindnesses. If he went to a soiree he usually staid but a short time, and even when away from home he generally refused private hospitality. Thus he was able to give almost undivided attention to the chief pursuit of his life. His residence in so accessible a part of London did, however, expose him to the constant invasion of callers, and his own good nature often rendered fruitless the efforts that were considerably made to restrict these within reasonable limits. Of course he suffered from the curious and the inconsiderate of the human species; and then there were those pertinacious bores, the dabble in science. "One morning a young man called on him, and with an air of great importance confided to him the result of some original researches (so he deemed them) in electrical philosophy. 'And pray,' asked the professor, taking down a volume of Rees's Cyclopaedia, 'did you consult this or any elementary work to learn whether your discovery had been anticipated?' The young man replied in the negative. 'Then why do you come to waste my time about well-known facts, that were published forty years ago?' 'Sir,' said the visitor, 'I thought I had better bring the matter to head-quarters immediately.' 'All very well for you, but not so well for head-quarters,' replied the professor, sharply, and set him down to read the article." "A grave, elderly gentleman once waited upon him to submit to his notice a new law of physics." The visitor requested that a jug of water and a tumbler might be brought, and then producing a cork, , You will be pleased to observe,' said he, 'how persistently this cork clings to the side of the glass when the vessel is half filled.' 'Just so,' replied the professor. 'But now,' resumed this great discoverer, 'mark what happens when I fill the tumbler to the brim. There! you see the cork flies to the centre-positively repelled by the sides !' 'Precisely so,' replied the amused electrician, with the air of a man who felt perfectly at home with the phenomenon, and indeed regarded it quite as an old friend. The visitor was evidently disconcerted. 'Pray how long have you known this?' he ventured to ask Faraday. 'Oh, ever since I was a boy,' was the rejoinder. Crestfallen-his discovery demolished in a moment-the poor gentleman was retiring with many apologies, when the professor, sincerely concerned at his disappointment, comforted him by suggesting that possibly he might some day alight upon something really new." **8** But there were other visitors who were right welcome to a portion of his time. One day it might be a young man, whom a few kind words and a little

experimenting. I recollect his meeting me at the entrance to the lecture theatre at Jermyn Street when Lyon Playfair was to give the first, or one of the first lectures ever delivered in the building. -"Let us go up here," said he, leading me far away from the central table. I asked him why he chose such an out-of-the-way place. "Oh," he replied, "we shall be able here to find out what are the acoustic qualities of the room." The simplicity of the means with which he made his experiments was often astonishing, and was, indeed, one of the manifestations of his genius. A good instance is thus narrated by Sir Frederick Arrow. "When the electric light was first exhibited permanently at Dungeness, on the 6th of June, 1862, a committee of the Elder Brethren, of which I was one, accompanied Faraday to observe it. We dined, I think, at Dover, and embarked in the yacht from there, and were out for some hours watching it, to Faraday's great delight-(a very fine night)-and especially we did so from the Varne light-ship, about equidistant between it and the French light of Grisnez, using all our best glasses and photometers to ascertain the relative value of the lights; and this brings me to my story. Before we left Dover, Faraday, with his usual bright smile, in great glee showed me a little common paper box, and, said, 'I must take care of this; it's my special photometer;' and then, opening it, produced a lady's ordinary black shawl-pin-jet, or imitation perhaps-and then bolding it a little way off the candle, showed me the image very distinct; and then, putting it a little further off, placed another candle near it, and the relative distance was shown by the size of the image. He lent me this afterward when we were at the Varne light-ship, and it acted admirably; and I ever since I have used one as a very convenient mode of observing, and I never do so but I think of that night and dear good Faraday, and his genial, happy way of showing how even common things may be made useful." After this Faraday modified his glass-bead photometer, and he might be seen comparing the relative intensity of two lights by watching their luminous images on a bead of black glass, which he had threaded on a string, and was twirling round so as to resolve the brilliant points into circles of fainter light; or he fixed the black glass balls on pieces of cork, and, attaching them to a little wheel, set them spinning for the same purpose. Some of these beads are preserved by the Trinity House, with other treasures of a like kind, including a flat piece of Bolder of an irregular oval form, turned up at one side so as to form a thumb-rest, and which served the philosopher as a candle-stick to support the wax-light that he used as a standard. The museum of the Royal Institution contains

to let you know, that you may, if you like, join the select few.

"Ever truly yours,

M; FARADAY."

It was, indeed, his wont to share with others the delight to a new discovery. Thus Sir Henry Holland tells me that he used frequently to run to his house in Brook Street with some piece of scientific news. One of these visits was after reading Bunsen and Kirchhoff's paper on Spectrum Analysis; and he did not stop short with merely telling the tale of the special rays of light shot forth by each metallic vapor, as the following letter will show. It is addressed to the present Baroness Burdett Coutts.

"ROYAL INSTITUTION, Friday, 17th May.

"DEAR MISS Coutts, - Tomorrow at 4 o'clock, immediately after Max Muller's lecture, I shall show Sir Henry Holland an apparatus which has , arrived from Munich to manifest the phenomena I of light. which have recently been made known I to us by Bunsen and Kirchhoff. Mr. Barlow will be here, and he suggests that you would like to know of the occasion. If you are inclined to see how philosophers work and live, and so are inclined to climb our narrow stairs (for I must show the experiments in my room), we shall be most happy to see you. The experiments will not be beautiful except to the intelligent.

"Ever your faithful servant,

M. FARADAY."

Sometimes, too, the exhibition of a scientific fact would take him away from home. Thus, when her majesty and the Prince Consort once paid a private visit to the Polytechnic, Mr. Pep- per arranged a surprise for the royal party by getting Faraday in a quiet room to explain the Ruhmkorff's coil -the latest development of his own inductive currents. This he did

SECTION IV

HIS METHOD OF WORKING.

IT is on record that when a young aspirant asked Faraday the secret of his success as a scientific investigator, he replied, "The secret is comprised in three words- Work, Finish, Publish." Each of these words, we may be sure, is full of meaning, and will guide us in a useful inquiry. Already in the "Story of his Life" we have caught some glimpses of the philosopher at work in his laboratory; but, before looking at him more closely, let us learn from a foreigner with what feelings to enter a place that is hallowed by so many memories sacred in the history of science. Professor Schonbein, of Basle, who visited England in 1840, says," During my stay in London, I once worked with Faraday for a whole day long in the laboratory of the Royal Institution, and I can not forbear to say that this was one of the most enjoyable days that I ever spent in the British capital. We commenced our day's work with breakfast; and when that was over I was supplied with one of the laboratory dresses of my friend, which, when I was presented in it to the ladies, gave occasion to no little amusement, as the dimensions of Faraday are different from those of my precious body. "To work with a man like Faraday was in itself a great pleasure; but this pleasure was not a little heightened in doing so in a place where such grand secrets of nature had been unfolded, the most brilliant discoveries of the century had been made, and entirely new branches of knowledge had been brought forth: For the empty intellect circumstances of this nature are indeed of little special value; but they stand in quite another relation to our power of imagination and inner nature. "I do not deny that my surroundings produced in me a very peculiar feeling; and while I trod the floor upon which Davy had once walked-while I availed myself of some instrument which this great discoverer had himself handled -while I stood working at the very table at which the ever-memorable man sought to solve the most difficult problems of science, at which Faraday enticed the first sparks out of the magnet, and discovered the most beautiful laws of I the chemical action of current electricity, I felt myself inwardly elevated, "and believed that I myself experienced something of the inbreathing of the scientific spirit which formerly ruled there with such creative power, and which still

"DEAR SIR,-The oil you noticed yesterday turns out to be liquid chlorine.

"Yours faithfully,

M. FARADAY."

But in other letters, as may be expected, there is found the enthusiasm of his ardent nature or in the glow of his genial spirit. An instance or " two may suffice

"ROYAL INSTITUTION, 24th March, 1843.

"DEAR SIR,-I have received and at once looked at your paper. Many thanks for so good a contribution to the beloved science. What glorious steps electricity has taken in the days with- in our remembrance, and what hopes are held out for the future! The great difficulty is to remove the mists which dim the dawn of a subject, and I can not but consider your paper as doing .very much that way for a most important part of natural knowledge.

"I am, my dear sir, most truly yours,

"M. FARADAY.

"J.P. JOULE, ESQ."

"ROYAL INSTITUTION, 15th Oct., 1853.

"My DEAR Miss MOORE,-The summer is going away, and I never (but for one day) had any hopes of profiting by-your kind offer of the roof of your house in Clarges Street. What a feeble summer it has been as regards sunlight! I have made a good many preliminary experiments at home, but they do not encourage me in the direction toward which I was looking. All is misty and dull, both the physical and the mental prospect. But I have ever found that the experimental philosopher has great need of patience, that he may not be downcast by inter- posing obstacles, and perseverance, that he may either overcome them, or open out a new path

of a fine but furious fall was very pleasant. There it remained motionless, while the gusts and clouds of spray swept furiously across its place, and were dashed against the rock. It looked like a spirit strong in faith and steadfast in the midst of the storm of passions sweeping across it; and though it might fade and revive, still it held on to the rock as in hope and giving hope; and the very drops, which in the whirlwind of their fury seemed as if they would carry all away, were made to revive it and give it greater beauty. "How often are the things we fear and esteem as troubles made to become blessings to those who are led to receive them with humility and I patience." In concluding this section, it may be well to string together a few gems from Faraday's lectures or correspondence, though they are greatly damaged by being torn away from their original setting: "After all, though your science is much to me, we are not friends for science sake only, but for something better in a man, something more important in his nature, affection, kindness, good feeling, moral worth; and so, in remembrance of these, I now write to place myself in your presence, and in thought shake hands, tongues, and hearts together.." This was addressed to Schonbein. "I should be glad to think that high mental powers insured something like a high moral sense, but have often been grieved to see the contrary; as also, on the other hand, my spirit has been cheered by observing in some lowly and uninstructed creature such a healthful, and honorable, and dignified mind as made one in love with human nature. When that which is good mentally and morally meet in one being, that that being is more fitted to work out and manifest the glory of God in the creation I fully admit." "Let me, as an old man who ought by this time to have profited by experience, say, that when I was younger I found I often misinterpreted the intentions of people, and found they I did not mean what at the time I supposed they meant; and further, that, as a general rule, it was better to be a little dull of apprehension when phrases seemed to imply pique, and quick in perception when, on the contrary, they seemed to imply kindly feeling. The real truth never fails ultimately to appear; and opposing parties, if wrong, are sooner convinced when replied to forbearingly than when overwhelmed." "Man is an improving animal. Unlike the animated world around him, which remains in the same constant state, he is continually varying; and it is one of the noblest prerogatives of his nature that in the highest of earthly distinctions he has the power of raising and exalting himself continually. The transitory state of man has been held up to him as a memento of his weakness: to man degraded it may be so with justice; to man as he ought to be it is no

know you will hear all the news from your appointed correspondent Jane, and, as I said, I am unable to chronicle any thing. Still, I am always very glad to hear how you are going on, and have a sight of all that I may see of the correspondence,

" Ever, my dear Frank, your affectionate uncle,

M. FARADAY;"

His scientific researches were very numerous. The Royal Society Catalogue gives under the name of Faraday a list of 158 papers, published in various scientific magazines or learned Transactions. Many of these communications are doubtless short, but a short philosophical paper often represents a large amount of brain-work; a score of them are the substance of his Friday evening discourses; while others are lengthy treatises, the records of long and careful investigations; and the list includes the thirty series of his "Experimental Researches in Electricity." These extended over a period of twenty seven years, and were afterward reprinted from the "Philosophical Transactions," and form three goodly volumes, with 3430 numbered paragraphs -one of the most marvelous monuments of Intellectual work, one of the rarest treasure-houses of newly-discovered knowledge, with which the world has ever been enriched. Faraday never published but one book in the common acceptance of the term-it was on "Chemical Manipulation ;" but there appeared another large volume of reprinted papers; and three of his courses of lectures were also published as separate small books, though not by himself It is very tempting to linger among these 158 papers; but this is not intended as a scientific biography, and those who wish to make themselves better acquainted with his work will find an admirable summary of it in Professor Tyndall's "Faraday as a Man of Science." In Sections IV. and V., however, I have endeavored to give an idea of his manner of working, and of the practical benefits that have flowed to mankind from some of his discoveries. As these papers appeared his fame grew wider and wider. When a comparatively young man he was naturally desirous of appending the mystic letters " F.R.S." to his name, and he was balloted into the Royal Society in January, 1824, not without strong opposition from his master, Sir Humphry Davy, then president. He paid the fees, and never sought another distinction ~ of the kind. But they were showered down upon him. The Philosophical Society of Cam-

during life, and necessary to life, is not life after all, why should electricity itself be life? Like heat, like chemical action, electricity is an implement of life, and nothing more." Whether the belief that electricity is life would be inconsistent with the Christian faith or not, it is clear that when an infidel preacher asserts that Faraday held such an opinion, his assertion will influence few who are not already disposed to materialism. Far more damaging is it to the cause of religion when her ministers repeat the assumption of the infidel that those who study the truths of nature are particularly prone to disbelieve. Yet such statements have been made, even with reference to Faraday. I have it on the best authority that one of the leading clergymen of the day, preaching on a special occasion from Peter's words, " The elements shall melt with fervent heat, the earth also and the works that are therein shall be burned up," spoke in antagonism to scientific men, alluding to Faraday by name, and to his computation of the tremendous electrical forces that would be produced by sundering the elements of one drop of water. "They shall be confuted by their own element-fire," added the preacher, careless of the conclusion which his audience might legitimately draw from such a two-edged argument. The accuser of the men of science was much astonished when told after his sermon by another clergyman that Faraday and other eminent physicists of the day were believers in a divine revelation. It maybe doubted whether Faraday ever tried to form a definite idea of the relation in which the physical forces stand to the Supreme Intelligence, as Newton did, or his own friend Sir John Herschel, nor did he consider it part of his duty as a lecturer to look beyond the natural laws he was describing. His practice in this respect has been well described by the Rev. Professor Pritchard: 6 "This great and good man never obtruded the strength of his faith upon those whom he publicly addressed; upon principle, he was habitually reticent on such topics, because he believed they were ill suited for the ordinary assemblages of men. Yet on more than one occasion when he had been discoursing on some of the magnificent prearrangements of divine Providence so lavishly scattered in nature, I have seen him struggle to repress the emotion which was visibly striving for utterance; and then, at the last, with one single far-reaching word, he would just hint at his meaning rather than express it. On such occasions he only who had ears to hear could hear." In his more familiar lectures to the cadets at Woolwich, however, he more than hinted at such elevated thoughts. In conversation, too, Faraday has been known to express his wonder that anyone should fail to recognize the constant traces of design;

Faraday to the last; and let me now tell you, that if I accepted the honor which the Royal Society desires to confer upon me, I would not answer for the integrity of my intellect for a single year.' In 1835 Sir Robert Peel desired to confer pensions as honorable distinctions on Faraday and some other eminent men. Lord Melbourne, who succeeded him as prime minister, in making the offer at a private interview, gave utterance to some hasty expressions that appeared to the man of science to reflect on the honor of his profession, and led to his declining the money. The king, William IV., was struck with the unusual nature of the proceeding, and kept repeating the story of Faraday's refusal; and about a month afterward, the premier, dining with Dr. (now Sir Henry) Holland, begged him to convey a letter to the professor, and to press on him the acceptance of the pension. The letter was couched in such honorable and conciliatory terms that Faraday's personal objection could no longer apply, and he expressed his willingness to receive this mark of national approval. A version of the matter that found its way into the public prints caused fresh annoyance, and nearly produced a final refusal, but, through the kind offices of friends who had interested themselves through-out in the matter, a friendly feeling was again arrived at, and the pension of £300 a year was granted and accepted." In 1858 the queen offered him a house at Hampton Court. It was a pretty little place, situated in the well-known green in front of the palace; and in that quiet retreat Faraday spent a large portion of his remaining years. In October, 1861, he wrote a letter to the managers of the Royal Institution, resigning part of his duties, in which he reviewed his connection with them. "I entered the Royal Institution in March, 1813, nearly forty-nine years ago, and, with exception of a comparatively short period, during which I was abroad on the Continent with Sir H; Davy, have been with you ever since. During that time I have been most happy in your kindness, and in the fostering care which the Royal Institution has bestowed upon me. Thank God, first, for all his gifts. I have next to thank you and your predecessors for the unswerving encouragement and support which you have given me during that period. My life has been a happy one, and all I desired. During its progress I have tried to make a fitting return for it to the Royal Institution, and through it to science. But the progress of years (now amounting in number to threescore and ten) having brought forth first the period of development, and then that of maturity, have ultimately produced for me that of gentle decay. This: has taken place in such a manner as to make the evening of life a blessing; for, while increasing physical weakness occurs, a full

"ROYAL INSTITUTION, Oct. 11th, 1849.

"My DEAR PERCY,-I can not be on the committee; I avoid every thing of that kind, that I may keep my stupid mind a little clear. As to I. being on a committee and not working, that is worse still. * * * Ever yours and Mrs. Percy's,

"M. FARADAY."

It is well known that he waged implacable war with the Spiritualists. Eighteen years ago tables took to spinning mysteriously under the fingers of ladies and gentlemen who sat or stood around the animated furniture; much was said about a new force, much too about strange revelations from another sphere, but Faraday made a simple apparatus which convinced him and most others that the tables moved through the unconscious pressure of the hands that touched them. The account of this will be found in the Athenaeum of July 2, 1853. Three weeks afterward he wrote to his friend Schonbein: "I have not been at work except in turning the tables upon the table-turners, nor should I have done that but that so many inquiries poured in upon me that I thought it better to stop the inpouring flood by letting all know at once what my views and thoughts were. What a weak, credulous, incredulous, unbelieving, superstitious, bold, frightened-what a ridiculous world ours is, as far as concerns the mind of man. How full of inconsistencies, contradictions, and absurdities it is !" But the believers in these occult phenomena, some of them holding high positions about the court, would not let him alone, and there are many indications of the annoyance and irritation they caused him. He declined to meet the professors of the mysterious art, and the following letter will serve to show the way in which he regarded them: ROYAL INSTITUTION, Nov. 1, 1864.

" SIR,-I beg to thank you for your papers, but have wasted more thought and time on so-called spiritual manifestation than it has deserved. Unless the spirits are utterly contemptible, they will find means to draw my

46th Psalm, and yesterday a great part of the 23d. We can only trust that it may be given us to say truly, "Thy will be done; indeed, the belief that all things work together for good to them that believe is an anchor of hope sure and steadfast to the soul. We are surrounded by most kind and affectionate friends, and it is indeed touching to see what warm feelings my dear uncle has raised on all sides." When his faculties were fading fast, he would sit long at the western window, watching the glories of the sunset; and one day, when his wife drew his attention to a beautiful rainbow that then spanned the sky, he looked beyond the falling shower and the many-colored arch, and observed, "He hath set his testimony in the heavens." On August 25, 1867, quietly, almost imperceptibly, came the release. There was a philosopher less on earth, and a saint more in heaven. The funeral, at his own request, was of the simplest character. His remains were conveyed to Highgate Cemetery by his relations, and deposited in the grave, according to the practice of his Church, in perfect silence. Few of his scientific friends were in London that bright summer-time, but Professor Graham and one or two of others came out from the shrubbery, and, joining the group of family mourners, took their last look, at the coffin. But when this sun had set below our earthly horizon, there seemed to spring up in the minds of men a great desire to catch some of the rays of the fading brightness and reflect them to posterity. A "Faraday Memorial" was soon talked of, and the work is now in the sculptor's hands. The Chemical Society has founded a "Faraday Lectureship" one of the new streets in Paris has been called "Rue Faraday;" biographical sketches have appeared in many of the British and Continental journals; successive books have told the story of his life and work; and in a thousand hearts there is embalmed the memory of this Christian gentleman and philosopher.

1. These books, with others bound by Faraday, are preserved in a special cabinet at the Royal Institution, together with more valuable documents—the laboratory notes of Davy and those of Faraday, his notes of Tatum's and Davy's lectures, copies of his published papers with annotations and indices, notes for lectures and Friday evening discourses, accounts and various memoranda, together with letters from Wollaston, Young, Herschel, Whewell, Mitscherlich, and many others of his fellow-workers

any such prize; or even if, as in your case, they came near me, have allowed them to move me from my course; and I have always contended that such rewards will never move the men who are most worthy of reward. Still, I think rewards and honors good if properly distributed, but they should be given for what a man has done" and not offered for what he is to do, or else talent must be considered as a thing marketable and to be bought and sold, and then down falls that high tone of mind which is the best excitement to a man of power, and will make him do more than any commonplace reward. When a man is rewarded for his deserts, he honors those who grant the reward, and they give it not as a moving impulse to him, but to all those by the reward are led to look to that man for an example." Eleven years afterward Faraday expressed similar views, but more fully; in a letter to the late Lord Wrottesley, as chairman of the Parliamentary Committee of the British Association:

"ROYAL INSTITUTION, March 10th, 1854.

"My LORD,—I feel unfit to give a deliberate opinion on the course it might be advisable for the government to pursue if it were anxious to improve the position of science and its cultivators in our country. My Course of life, and the circumstances which make it a happy one for me, are not those of persons who conform to the usages and habits of society. Through the kindness of all, from my sovereign downward, I have that which supplies all my need; and in respect of honors, I have, as a scientific man, received from foreign countries' and sovereigns those which, belonging to very limited and select classes, surpass in my opinion any thing that it is in the power of my own to bestow. "I can not say that I have not valued such distinctions; on the contrary, I esteem them very highly, but I do not think I have ever worked for or sought after them. Even were such to be now created here, the time is past when these would possess any attraction for me; and you I will see, therefore, how unfit I am, upon the strength of any personal motive or feeling, to judge of what might be influential upon the minds of others. Nevertheless, I will make one or two remarks which have often occurred to my mind. "Without thinking of the effect it might have upon distinguished men of science, or upon the minds of those who, stimulated to exertion, might become distinguished, I do think that a government should for its own sake honor the men who do honor and service to the country. I refer now to honors only, not to beneficial rewards; . of such honors I think there are none.

8 British Quarterly Review, April, 1868.

9. No wonder the celebrated electrician, P. Riess, of Berlin; once addressed a long letter to him as "Professor Michael Faraday, Member of all Academies of Science, London."

SECTION II

STUDY OF HIS CHARACTER

IN the previous section we have traced the leading events of a life which was quietly and uniformly successful. We have watched the passage of the errand-boy into the philosopher, and we have seen how at first he begged for the meanest place in a scientific workshop, and at last declined the highest honor which British science was capable of granting. His success did not lie in the amassing of money—he deliberately turned aside from the path of proffered wealth; nor did it lie in the attainment of social position and titles—he did not care for the weight of these. But if success consists in a life full of agreeable occupation, with the knowledge that its labors are adding to the happiness and wealth of the world, leading on to an old age full of honor, and the prospect of a blissful immortality, then the highest success crowned the life of Faraday. How did he obtain it? Not by inheritance, and not by the force of circumstances. The wealth or the reputation of fathers is often an invaluable starting-point for sons; a liberal education and the contact of superior minds in early youth is often a mighty help to the young aspirant: the favor of powerful friends will often place on a vantage ground the struggler in the battle of life. But Faraday had none of these. Accidental circumstances sometimes push a man forward, or give him a special advantage over his fellows; but Faraday had to make his circumstances, and to seize the small favors that fortune sometimes threw in his way. The secret of his success lay in the qualities of his mind. It is only fair, however, to remark that he started with no disadvantages. There was no stain in the family history: he had no dead weight to carry, of a disgraced name, or of bad health, or deficient faculties, or hereditary tendencies to vice. It must be

that of the wafers in the basin." When a young lecturer, Faraday took lessons in elocution from Mr. Smart, and was at great pains to cure himself of any defeat of pronunciation or manner; for this purpose he would get a friendly critic to form part of his audience. On the fly-leaves of many of the notes of his lectures are written the reminders, "Stand up"—"Don't talk quick." Indeed, in early days, it was so much a matter of anxiety to him that every thing in his lectures should be as perfect as possible, that he not only was accustomed to go over every thing again and again in his mind, but the difficulty of satisfying himself used to trouble his dreams. I was told this, if I am not mistaken, by himself; and it goes far to explain how his discourses possessed such a fascination. Some of his feelings in regard to lecturing may be learned from the following particulars, for I which I am indebted to Mr. Charles Tomlinson. They relate to a course of lectures he delivered in 1849 on Statical Electricity. The first lecture began thus: "Time moves on, and brings changes to ourselves as well as to science. I feel that I must soon resign into the hands of my successors the position which I now occupy at this table. Indeed, I have long felt how much rather I would sit among you and be instructed, than stand here and attempt to instruct. I have always felt my position in this Institution as a very strange one. Coming after such a man as Davy, and associated with such a man as Brande, and having had to make a position for myself, I have always felt myself here in a strange position. You will wonder why I make these remarks. It is not from any affectation of modesty that I do so, but I feel that loss of memory may soon incapacitate me altogether for my duties. Without, however, troubling you more about myself, let us proceed to the subject before us, and fall back upon the beginnings of the wonderful science of electricity. I shall have to trouble you with very little of them. The facts are so wonderful that I shall not attempt to explain them." At the second lecture, Faraday advanced to the table at three o'clock, and began to apologize for an obstruction of voice, which indeed was painfully evident. He said that, 'in an engagement where the contracting parties were one and many, the one ought not, on any slight ground, to break his part of the engagement with the many, and therefore, if the audience would excuse his imperfect utterance, he would endeavor—' Murmurs arose: 'Put off the lecture.' Faraday begged to be allowed to go on. A medical man then rose and said he had given it as his opinion that it would be dangerous to Dr. Faraday to proceed. Faraday again urged his wish to proceed—said it was giving so much trouble to the ladies, who had

don't like to be beaten by something that I have once tried to do." The same principle is apparent in that long series of electrical researches, where for a quarter of a century he marched steadily along that path of discovery into which he had been lured by the genius of Davy. And so, whatever course was set before him, he ran with patience toward the goal, not diverted by the thousand objects of interest which he passed by, nor stopping to pick up the golden apples that were flung before his feet. This tremendous faculty of work was relieved by a wonderful playfulness. This rarely appears in his writings, but was very frequent in his social intercourse. It was a simple-hearted joyousness, the effervescence of a spirit at peace with God and man. It not seldom, however, assumed the form of good-natured banter or a practical joke. Indications of this playfulness have already been given, and I have tried to put upon paper some instances that occur to my own recollection, but the fun depended so much upon his manner that it loses its aroma when separated from himself. However, I will try one story. I was spending a night at a hotel at Ramsgate when on light-house business. Early in the morning there came a knock at the bedroom door, but, as I happened to be performing my ablutions, I cried "Who's there?" "Guess." I went over the names of my brother commissioners, but heard only "No, no," till, not thinking of any other friend likely to hunt me up in that place, I left off guessing; and on opening the door, I saw Faraday enjoying with a laugh my inability to recognize his voice through a deal board. A student of the late Professor Daniell tells me that he remembers Faraday often coming into the lecture-room at King's College just when the professor had finished and was explaining matters more fully to any of his pupils who chose to come down to the table. On the day the subject discoursed on and illustrated had been sulphureted hydrogen, and a little of the gas had escaped into the room, as it perversely will do. When Faraday entered he put on a look of astonishment, as though he had never smelt such a thing before, and in a comical manner said, "Ah! A savory lecture, Daniell!" On another occasion there was a little ammonia left in a jar over mercury. He pressed Daniell to tell him what it was, and when the professor had put his head down to see more clearly, he whiffed some of the pungent gas to his face. Occasionally this humor was turned to good account, as when, on Friday evening before the lecture, he told the audience that he had been requested by the managers to mention two cases of infringement of rule. The first related to the red cord which marks off the members' seats. "The second case I take to be a hypothetical one, namely, that of a

it is not the subject, so much as the man; but if he is not competent, and does not feel that there is a need of competency to convey his ideas gently, and quietly, and simply to the young mind, he simply throws up obstacles, and will be found using words which they will not comprehend." These were the words of his later days, but fortunately he felt "the need of competency" before his own habits were formed, and in four letters to "Abbott we find wonderfully sagacious observations on the matter, which it would be well for : any young lecturer to study. He describes the proper arrangement of a lecture room, dwelling on the necessity of good ventilation; and then, having considered the fittest subjects for popular lectures, he turns to the character of the audience, and shows how that must be studied; for some expect to be entertained by the manner of the lecturer as well as his subject, while others care for something which will instruct. He dwells on the superiority of the eye over the ear as a channel of knowledge, and lays down some rules for this kind of instruction, which he of all men subsequently carried out to perfection. "Apparatus is an essential part of every lecture in which it can be introduced. Diagrams and tables, too, are necessary, or at least add in an eminent degree to the illustration and perfection of a lecture. When an experimental lecture is to be delivered, and apparatus is to be exhibited, some kind of order should be observed in the arrangement of them on the lecture table. Every particular part illustrative of the lecture should be in view; no one thing should hide another from the audience, nor should any thing stand in the way of or obstruct the lecturer. They should be so placed, too, as to produce a kind of uniformity in appearance. No one part should appear naked and another crowded; unless some particular reason exists and makes it necessary to be so. At the same time, the whole should be so arranged as to keep one operation from interfering with another." A good delivery comes in for its share of praise; "for though, to all true philosophers, science and nature will have charms innumerable in every dress, yet I am sorry to say that the generality of mankind can not accompany us one short hour unless the path is strewn with flowers." Then, "a lecturer should appear easy and collected, undaunted and unconcerned, his thoughts about him, and his mind free and clear for the contemplation and description of his subject. His action should not be hasty and violent, but slow, easy, and natural, consisting principally in changes of the posture of the body, in order to avoid the air of stiffness or sameness that would otherwise be unavoidable. His whole behavior should evince respect for his audience, and he should in no case forget

Garibaldi thinks he can learn any thing from us, we shall be happy to see him," was Faraday's reply. This nobility of regard not only preserved him from envying the success of other explorers in the same field, but I led him heartily to rejoice with them in their discoveries. Dumas gives us a picture of Foucault showing I. Faraday some of his admirable experiments, and of the two men looking at one another with eyes moistened, but full of bright expression, as they stood hand in hand, silently thankful—the one for the pleasure he had experienced, the other for the honor that had been done him. He also tells how, on another occasion, he breakfasted at Albemarle Street, and during the meal Mr. Faraday made some eulogistic remarks upon Davy, which were coldly received by his guest. After breakfast he was taken down stairs to the anteroom of the lecture theatre, when Faraday, walking up to the portrait of his old master, exclaimed, "Wasn't he a great man!" then turning round to the window next the entrance door, he added, "It was there that he spoke to me for the first time." The Frenchman bowed. They descended the stairs again to the laboratory. Faraday pulled out an old note-book, and, turning over its pages, showed where Davy had entered the means by which the first globule of potassium was produced, and had drawn a line round the description, with the words 'Capital experiment.' The French chemist owned himself vanquished, and tells the tale in honor of; him who remembered the greatness and forgot the littlenesses of his teacher. And the respect he showed to others he required to be shown to himself. It is difficult to imagine anyone taking liberties with him, and it was only in early life that there were small-minded creatures who would treat him, not according to what he was, but according to the position from which he had risen. His servants and work-people were always attentive to the smallest expression of his wish. Still, he did not "go through life with his elbows out." He once wrote to Matteucci; "I see that that moves you which would move me most, viz., the imputation of a want of good faith; and I cordially sympathize with anyone who is so charged unjustly. Such cases have seemed to me almost the only ones for which it is worth while entering into controversy. I have felt myself not unfrequently misunderstood, often misrepresented, sometimes passed by, as in the cases of specific inductive capacity, magneto-electric currents, definite electrolytic action, etc., etc.; but it is only in the cases where moral turpitude has been implied that I have felt called upon to enter on the subject in reply." Yet, where he felt that his honor was impugned, none could be more sensitive or more resolute. This desire to clear himself,

public education has taken a far deeper hold on the feelings and the hopes of the nation, and it is not merely the extent of the instruction, but its nature also, that is discussed. It is held to be no longer right that the minds of our youth should be fed almost exclusively on the dry husks of classic or mediaeval knowledge, while the rich banquet of modern discovery remains untasted. Yet it is hard for natural science to gain an honored place in our venerable scholastic institutions. Faraday, however, had long formed his conclusions on this subject. In one of his Friday evening discourses he says: "The development of the applications of physical science in modern times has become so large and so essential to the well-being of men, that it may justly be used as illustrating the true character of pure science as a department of knowledge, and the claims it may have for consideration by governments, universities, and all bodies to whom is confided the fostering care and direction of learning. As a branch of learning, men are beginning to recognize the right of science to its own particular place; for, though flowing in channels utterly different in their course and end from those of literature, it conduces not less, as a means of instruction, to the discipline of the mind, while it ministers more or less to the wants, comforts, and proper pleasure, both mental and bodily, of every individual of every class in life. Until of late years, the education for, and recognition of it by the bodies which may be considered as governing the general course of all education, have been chiefly directed to it only as it could serve profession as services, viz., those which are remunerated by society; but now the fitness of university degrees in science is under consideration, and many are taking a high view of it, as distinguished from literature, and think that it may well be studied for its own sake, i.e., as a proper exercise of the human intelligence, able to bring into action and development all the powers of the mind. As a branch of learning, it has (without reference to its applications) become as extensive and varied as literature; and it has this privilege, that it must ever go on increasing." On the subject of scientific education Faraday was examined by the Public Schools Commission, November 18th, 1862, and his sentiments, of course, appear in their report. He said to them, "That the natural knowledge which has been given to the world in such abundance during the last fifty years should remain untouched, and that no sufficient attempt should be made to convey it to the young mind growing up and obtaining its first views of those things, is to me a matter so strange that I find it difficult to understand. Though I think I see the opposition breaking away, it is yet a very hard one to overcome. That it

sum in arithmetic became a delight when he undertook to explain it, and that when the little girl was naughty and rebellious, he could gently win her round, telling her how he used to feel himself when he was young, and advising her to submit to the reproof she was fighting against. Nor were his own relatives the only sharers of this kindness. One friend cherishes among his earliest recollections that of Faraday making for him a fly-cage and a paper purse, which had a real bright half-crown in it. When the present Mr. Baden Powell was a little fellow of thirteen, he used to give short lectures on chemistry in his father's house, and the philosopher of Albemarle Street liked to join the family audience, and would listen and applaud the experiments heartily. When one day my wife and I called on him with our children, he set them playing at hide-and-seek in the lecture theatre, and afterward amused them up stairs with tuning-forks and resounding glasses. At a soiree at Mr. Justice Grove's, he wanted to see the younger children of the family; so the eldest daughter brought down the little ones in their night-gowns to the foot of the stairs, and Faraday expressed his gratification with "Ah! that's the best thing you have done to-night." And when his faculties had nearly faded, it is remembered how the stroking of his hand by Mr. Vincent's little daughter quickened him again to bright and loving interest. It would be easy to multiply illustrations of this kindness in various relations of life. Here is one of his own telling, where certainly the effect produced was not owing to any knowledge of how princely an intellect underlay the loving spirit. It is from a journal of his tour in Wales: "Tuesday, July 20th. After dinner I set off on a ramble to Melincourt, a waterfall on the north side of the valley, and about six miles from our inn. Here I got a little damsel for my guide who could not speak a word of English. We, however, talked together all the way to the fall, though neither knew what the other said. I was delighted with her burst of pleasure as, on turning a corner, she first showed me the waterfall. While I was admiring the scene, my little Welsh damsel was busy running about, even under the stream, gathering strawberries. On returning from the fall, I gave her a shilling that I might enjoy her pleasure: she courtesied, and I perceived her delight. She again ran before me back to the village, but wished to step aside every now and then to pull strawberries. Every bramble she carefully moved out of the way, and ventured her bare feet to try stony paths, that she might find the safest for mine. I observed her as she ran before me, when she met a village companion, open her hand to show her prize, but without any stoppage, word, or other motion. When we

subject, and I have the pleasure of thinking that nature confirms my original conclusions. So, though evidence may appear to preponderate extremely in favor of a certain decision, it is wise and proper to hear a counter-statement. You can have no idea how often, and how much, under such an impression, I have desired that the marvelous descriptions which have reached me might prove, in some points, correct; and how frequently I have submitted myself to hot fires, to friction with magnets, to the passes of hands, etc., lest I should be shutting out discovery-encouraging the strong desire that something might be true, and that I might aid in the development of a new force of nature." He turns then to another evil, and its cure: "The tendency to deceive ourselves regarding all we wish for, and the necessity of resistance to these desires. The force of the temptation which urges us to seek for such evidence and appearances as are in favor of our desires, and to disregard those which oppose them, is wonderfully great. In this respect we are all, more or less, active promoters of error." He winds up his remarks upon this subject with the italicized sentence: "I will simply express my strong belief that that point of self-education which consists in teaching the mind to resist its desires and inclinations until they are proved to be right, is the most important of all, not only in things of natural philosophy, but in every department of daily life." He turns then to the necessity of a "habit of forming clear and precise ideas," and of expressing them in "clear and definite language:" "When the different data required are in our possession, and we have succeeded in forming a clear idea of each, the mind should be instructed to balance them one against another, and not suffered carelessly to hasten to a conclusion." "As a result of this wholesome mental condition, we should be able to form a proportionate judgment.." i. e., one proportionate to the evidence, ranging through all degrees of probability- while he adds: "Frequently the exercise of the judgment ought to end in absolute reservation." "the education which I advocate," says Faraday, "will require patience and labor of thought in every exercise tending to improve the judgment. It matters not on what subject a person's mind is occupied, he should engage in it with the conviction that it will require mental labor." "Because the education is internal, it is not the less needful; nor is it more the duty of a man that he should cause his child to be taught, than that he should teach himself Indolence may tempt him to neglect the self-examination and experience which form his school, arid weariness may induce the evasion of the necessary practices; but surely a thought of the prize should suffice to

'From his friend, Michael Faraday.' Those who live alone in London, unknown and uncared for by any around them, can best appreciate these marks of attention which Mr. Faraday invariably showed, and not only to myself, but equally to my fellow-assistant in the chemical laboratory." The following instance among many that might be quoted will illustrate his readiness to take trouble on behalf of others. When Dr. Noad was writing his "Manual of Electricity," a doubt crossed his mind as to whether Sir Snow Harris's unit jar gave a true measure of the quantity of electricity thrown into a Leyden jar: he asked Faraday, and his doubt was confirmed. Shortly afterward he received a letter beginning thus:

My DEAR SIR, -While looking over my papers on induction, I was reminded of our talk about Harris's unit jar, and recollected that I had given you a result just there reverse of my old conclusions, and, as I believe, of the truth. I think the jar is a true measure, so long as the circumstances of position, etc., are not altered; for its discharge and the quantity of electricity thus passed on depends on the constant relation of the balls connected with the inner and outer surface coating to each other, and is independent of their joint relation to the machine, battery, etc. Perhaps I have not made my view clear, but next time we meet remind me of the matter.

"Ever truly yours,

M. FARADAY."

And just a week afterward Dr. Noad received a second letter, surmounted by a neat drawing, and describing at great length experiments that the professor had since made in order to place the matter beyond doubt. And it was not merely for friends and brother savants that he would take trouble. Old volumes of the Mechanics' Magazine bear testimony to the way in which he was asked questions by people in all parts of the kingdom, and that he was accustomed to give painstaking answers to such letters. "Do to others as you would wish them to do to you," was a precept often on his lips. But I have heard that he was sometimes charged with transgressing it himself, inasmuch as he took an amount of trouble for other people which he would have been very distressed if they had taken

similar thoughts. Here are two instances, the first from a lecture thirty years afterward, the second from a private letter: "We may be sure of facts, but our interpretation of facts we should doubt. He is the wisest philosopher who bolds his theory with some doubt; who is able to proportion his judgment and confidence to the value of the evidence set before him, taking a fact for a fact, and a supposition for a supposition; as much as possible keeping his mind free from all source of prejudice, or, where he can not do this (as in the case of a theory), remembering that such a source is there." The letter is to Mr. Frederick Field, and relates to a paper on the existence of silver in the water of the ocean.

"ROYAL INSTITUTION, 21st October, 1856.

"My DEAR SIR,-Your paper looks so well, that, though I am of course unable to become security for the facts, I have still thought it my duty to send it to the Royal Society. Whether it will appear there or not I can not say-no one can say even for his own papers; but for my part, I think that, as facts are the foundation of science, however they may be interpreted, so they are most valuable, and often more so than the interpretations founded upon them. I hope your further researches will confirm those you have obtained; but I would not be too hasty with them-rather wait a while, and make them quite secure.

"I am, sir, your obliged servant,

"M. FARADAY."

How pleasant it would have been to peep into his mind, and watch the process by which he was transferred into the very image of his ideal philosopher! He has partially told us the secret in two remarkable lectures, one of which was delivered before the City Philosophical Society when he was only twenty-seven years of age, while the other formed part of a series of Education at Albemarle Street. Copious extracts

feeling awakened in the minds of others by this kindness was indeed a source of the purest pleasure to himself; trifling proofs of interest or love could easily move his thankfulness; and he richly enjoyed the appreciation of his scientific labors. This would often break forth in words. Thus, in the middle of II. letter to A. De la Rive, principally on scientific matters, he writes: "Do you remember one hot day, I can not tell how many years ago, when I was hot and thirsty in Geneva, and you took me to your house in the town and gave me a glass of water and raspberry vinegar? That glass of drink is refreshing to me still." Again: "Tyndall, the sweetest reward of my work is the sympathy and good will which it has caused to flow in upon me from all quarters of the world." But to estimate rightly this amiability of character, it must be distinctly remembered that it was not that superabundance of good nature which renders some men incapable of holding their own, or rebuking what they know to be wrong. In proof of this, his letters to the spiritualists might be quoted; but the following I have not hitherto seen the light; They are addressed to two different parties whose inventions came officially before him. "You write 'private' on the outside. of your official communication, and 'confidential' within. I will take care to respect these instructions as far as falls within my duty; but I can have nothing private or confidential as regards the Trinity House, which is my chief: Whatever opinion I send to them I must accompany with the papers you send me. If, therefore, you wish any thing held back from them, send me another official answer, and I will return you the one I have, marked 'confidential.' Our correspondence is indeed likely to become a little irregular, because your papers have not come to me through the Trinity House. You will feel that I can not; communicate any opinion I may form to you: I am bound to the Trinity House, to whom I must communicate in confidence. I have no objection to your knowing my conclusions; but the Trinity House is the fit judge of the use it may make of them, or the degree of confidence they may think they deserve, or the parties to whom they may choose to communicate them." By a foot-note it appears that the private and confidential communication was returned to the writer, by desire, four days afterward.

"SIR,-I have received your note and read your pamphlet. There is nothing in either which makes it at all desirable to me to see your apparatus, for I have not time to spare to look at a matter two or three times over. In referring to ---, I suppose you refer also to his application to the Trinity

formal profession of his faith till a month after his marriage, when nearly thirty years of age. Of his spiritual history up to that period little is known, but there seem to be good grounds for believing that he did not accept the religion of his fathers without a conscientious inquiry into its truth. It would be difficult to conceive of his acting otherwise. But after he joined the Sandemanian Church, his questionings were probably confined to matters of practical duty; and to those who knew him best nothing could appear stronger than his conviction of the reality of the things he believed. In order to understand the life and character of Faraday, it is necessary to bear in mind not merely that he was a Christian, but that he was a Sandemanian. From his earliest years that religious system stamped its impress deeply on his mind; it surrounded the blacksmith's son with an atmosphere of unusual purity and refinement; it developed the unselfishness of his nature, and in his after career it fenced his life from the worldliness around, as well as from much that is esteemed as good by other Christian bodies. To this small self-contained sect he clung with warm attachment; he was precluded from Christian communion or work outside their circle, but his sympathies at least burst all narrow bounds. Thus the Abbe Moigno tells us that at Faraday's request he one day introduced him to Cardinal Wiseman. The interview was very cordial, and his eminence did not hesitate frankly and good-naturedly to ask Faraday if, in his deepest conviction, he believed all the Church of Christ, holy, catholic, and apostolical, was shut up in the little sect in which he bore rule. "Oh no !" was the reply; "but I do believe from the bottom of my soul that Christ is with us." There were other points, too, in his character, which reflected the coloring of the religious school to which he belonged. Thus, while humility is inseparable from a Christian life, there is a special phase of that virtue bred of those doctrines which teach that all our righteousness must be the unmerited gift of another: these doctrines are strongly insisted upon in the Sandemanian Church, and this humility was acquired in an intense degree by its minister. Again, while all Christians deplore the terrible amount of folly and sin in the world, most recognize also a large amount of good, and believe in progressive improvement; but small communities are apt to take gloomy views, and so did Faraday, - notwithstanding his personal happiness, and his firm conviction that "there is One above who worketh in all things, and who governs even in the midst of that misrule to which the tendencies and powers of men are so easily perverted." In writing to Professor Schonbein and a few other

of the tools had annoyed him, and that he was weary. "No, my dear Mr. Noble," said Faraday, putting his hand on his shoulder, "but, the noise reminded me of my father's anvil, and took me back to my boyhood." This deep affection peeps out constantly in his letters to different members of his family, "bound up together," as he wrote to his sister-in-law, "in the one hope, and in faith and love which is in Jesus Christ." But it was toward his wife that his love glowed most intensely. Yet how can we properly speak of this sacred relationship; especially as the mourning widow is still among us? It may suffice to catch the glimpse that is reflected in the following extract from a letter he wrote to Mrs. Andrew Crosse on the death of her husband:

"July 12, 1855.

". ...Believe that I sympathize with you most deeply, for I enjoy in my life-partner those things which you speak of as making you feel your loss so heavily: "It is the kindly domestic affections, the worthiness, the mutual aid in sorrow, too mutual joy in happiness that has existed, which makes the rupture of such a tie as yours so heavy to bear; and yet you would not wish it otherwise, for the remembrance of those things brings solace with the grief: I speak, thinking what my own trouble would be if I lost my partner; and I try to comfort you in the only way in which I think I could be comforted.

M. FARADAY."

There was, as Tyndall has observed, a mixture of chivalry with this affection. In his book of diplomas he made the following remarkable entry:

"25th January, 1847.

"Among these records and events, I here insert the date of one which, as a source of honor and happiness, far exceeds all the rest. We were married on June 12, 1821.

"M.FARADAY."

.... " Look, how the floor of heaven is thick
inlaid with patines of blight gold;
There's not the smallest orb, which thou behold'st,"
But in his motion like an angel sings,
Still quiring to the young-eyed cherubins :
Such harmony is in immortal souls;
But, whilst this muddy vesture of decay
Doth grossly close us in, we can not hear it."

Faraday, who happened not to be familiar with the passage, made his friend repeat it over and over again as he drank in the whole meaning of the poetry, for there is a true sense in which no other mortal had ever opened his ears so fully to the harmony of the universe. From the plains of mental mediocrity there occasionally rise the mountains of genius, and from the dead level of selfish respectability there stand out now and then the peaks of moral greatness. Neither kind of excellence is so common as we could wish it, and it is a rare coincidence when, as in Socrates, the two meet in the same individual. In Faraday we have a modern instance. There are persons now living who watched this man of strong will and intense feelings raising himself from the lower ranks of society, yet without losing his balance; rather growing in simplicity, disinterestedness, and humility as princes became his correspondents, and all the learned bodies of the world vied with each other to do him homage; still finding his greatest happiness at home, though reigning in the affections of all his fellows; loving every honest man, however divergent in opinion, and loved most by those who knew him best. This is the phenomenon. By what theory is it to be accounted for? The secret did not lie in the nature of his pursuits. This can, not be better shown than in the following incident furnished me by Mrs. Crosse: "One morning, a few months after we were married, my husband took me to the Royal Institution to call on Mr. and Mrs. Faraday. I had not seen the laboratory there, and the philosopher very kindly took us over the Institution, explaining for my information many objects of interest. His great vivacity and cheeriness of manner surprised me in a man who devoted his life to such abstruse studies, but I have since learned to know that the highest philosophical nature is often, indeed generally, united with an almost childlike simplicity." "After viewing the ample appliances for experimental research, and feeling impressed by the scientific atmosphere of the place, I turned and said, ' Mr. Faraday, you must be very happy in

mind. And while he knew no reason for concealment, there was no trace of self-conceit about him, nor any pretense at being what he was not. To illustrate this quality is not so easy; the indications of it, like his humor, were generally too delicate to be transferred to paper; but perhaps the following letter will do as well as any thing else, for there are few philosophers who could have written so naturally about the pleasures of a pantomime and then about his highest hopes:

"ROYAL INSTITUTION, LONDON, W.,
1st Jan., 1857.

"My DEAR MISS Coutts,-You are very kind to think of our pleasure and send us entrance to your box for to-morrow night. We thank you very sincerely, and I mean to enjoy it, for I still have a sympathy with children, and all their thoughts and pleasure. Permit me to wish you very sincerely a happy year; and also to Mrs. Brown. With some of us our greatest happiness will be content mingled with patience; but there is much happiness in that and the expected end. Ever your obliged servant,

"M. FARADAY." 3

As to truthfulness: he was not only truthful in the common acceptation of the word, but he did not allow, either in himself or others, hasty conclusions, random assertions, or slippery logic. "At such times he had a way of repeating the suspicious statement very slowly and distinctly, with an air of wondering scrutiny as if it had astonished him. His irony was then irresistible, and always produced a modification of the objectionable phrase." "An acquaintance rather given to inflict tedious narratives on his friends was descanting to Faraday on the iniquity of some coachman who had set him down the previous night in the middle of a dark and miry road-'in fact,' said the 'irksome drawler, 'in a perfect morass; and there I was, as you may imagine, half the night, plunging and struggling to get out of this dreadful morass.' 'More ass you rapped out the philosopher at the top of his scale of laughter." This was a rare instance, for it was only when much provoked that he would perpetrate a pun, or depart from the kind courtesy of his habitual talk. That he was quite ready to give up a statement or view when it was proved by others to be incorrect, is shown by the Preface to the volumes in which are reprinted his "Experimental Researches." "In giving advice," says Miss

Reid, "he always went back to first principles, to the true right and wrong of questions, never allowing deviations from the simple straight-forward path of duty to be justified by custom or precedent; and he judged himself strictly by the same rule which he laid down for others." These beauties of character were not marred by serious defects or opposing faults. "He could not be too closely approached. There were no shabby places or ugly corners in his mind." Yet he was very far from being one of those passionless men who resemble a cold statue rather than throbbing flesh and blood. He was no "model of all the virtues," dreadfully uninteresting, and discouraging to those who feel such calm perfection out of their reach. 'His inner life was a battle, with its wounds as well as its victory. Proud by nature, and quick-tempered, he must have found the curb often necessary; but, notwithstanding the rapidity of his actions and thoughts, he knew how to keep a tight rein on that fiery spirit. I have listened attentively to every remark in disparagement of Faraday's character, but the only serious ones have appeared to me to arise from a misunderstanding of the man-a misunderstanding the more easy because his standard of right and wrong often differed from the notions current around him. Still, it may be true that his extreme sensitiveness led him sometimes to do scant justice to those who he imagined were treading too closely in his own foot-steps; as, for instance, when Nobili brought out some beautiful experiments on magnetism, just after the short notice of his own discoveries in 1831 which Faraday had sent to M. Hachette, and which was communicated to the Academie des Sciences. It is true also that, with his great caution and his repugnance to moral evil, he was more disposed to turn away in disgust from an erring companion than to endeavor to reclaim him. It has also been imputed to him as a fault that he founded no school, and took no young man by the hand as Davy had taken him. That this was rather his misfortune than his fault would appear from words he once wrote to Miss Moore: "I have often endeavored to discover a genius, but have not been very successful, though many cases seemed promising at first." The world would doubtless have been the gainer if he had stamped his own image on the minds of a group of disciples; but a man can not do every thing; and had Faraday been more of a teacher, he would perhaps have been less of an investigator. It has been previously remarked that Faraday took little part in social movements, and went little into society, but it must not be supposed that he was by any means unsocial. It seems probable that his freedom in this matter was somewhat hampered by the principles in which he had been