56 SOME OBSERVATIONS ON AN ANNIVERSARY
OCTOBER 23, 1967 HOKE S. GREENE

INTRODUCTION

August 25, 1967, marked the one hundredth anniversary of the death of the great English chemist and physicist - Michael Faraday. To scientists and historians of science Faraday was perhaps the greatest physical scientist who ever lived, irrespective of the criteria used in making a judgment. In breadth of his research activities, in influence upon the industrial revolution, in impact and effect on other scientists - in all of these Faraday excelled. He is one of a very small class of supreme scientists including Archimedes, Galileo, Newton, Lavosier and Darwin. Einstein once said that the history of physical science contains two couples of equal magnitude; Galileo and Newton on the one hand and Faraday and Maxwell on the other. This is one of the more interesting of Einstein's equations. Certainly Maxwell was not the equal of either Newton or Galileo and therefore Faraday was the greater of them all.

In view of his renown as a scientist, much has been written in the last 100 years about his scientific researches and their influence on the industrial era in which we live. Other aspects of his life, such as his personal beliefs and standards, his social and religious activities, and his work as a 19th century philanthropist, have been rather neglected. It is about these phases of the life of this great and good man that this paper will be concerned.

HIS YOUTH

He was born on September 22, 1791, at Newington Butts in Surrey on the outskirts of London. His father was a blacksmith and his mother the daughter of a farmer. Neither had more than the bare rudiments of an education. To his pedigree Faraday therefore owes little for the genius that made him the great man and scientist that he was, even though his mother did claim to be of Irish decent.

When Michael was five his family moved into London to take up residence in Jacob's Wells Mews, off Charles Street, Manchester Square. Here he played marbles in the streets and went to the elementary school

that was provided for the poor of this section of London. He himself once said "My education was of the most ordinary description, consisting of little more than the rudiments of reading, writing and arithmetic at a common day school. My hours out of school were passed at home and in the streets".

Even this meager formal education ceased at age 13 when he became an errand boy to George Ribau, a book seller, to help support his father who had become an invalid. His main task was the carrying of newspapers. In those days most papers were rented rather than sold and news boys had to make two trips per customer - one to deliver and another to collect. A boyhood acquaintance recalled seeing Faraday running, not walking, to deliver and collect his papers. On Sundays he began particularly early in order to finish by church time.

Mr. and Mrs. Ribau were immediately impressed by young Michael's energy, enthusiasm and seriousness of purpose. Consequently he was at age 14 promoted to bookbinding apprentice. He served in this capacity for six years, certainly some of the more important ones of his life; for it was during these busy years that self-education for his life as a scientist began. His main task was to bind books and manuscripts that were brought into the shop and he early developed the habit of reading as many of these volumes as possible - even delaying binding to do so.

It was also during this period that Mr. Ribau gave him tickets to the theater and to various lectures, including those on Natural Philosophy at the house of a Mr. Tatum. It was here that his growing interest in science was sharpened. He also met two young men - Benjamin Abbot and Alfred Huxtable. Young Abbot was a Quaker and quite well educated. He and Michael became fash friends, forming together what they called a "Self-Improvement Society", one purpose of which was to write long letters or epistles to each other elaborating on their important thoughts and ideas. Thus began Faraday's habit of letter writing which he continued prolifically throughout his life. Many of his thousands of letters have been preserved, including a few of those he wrote to his sweetheart and future wife during their courtship.

It is in his letters that the true Faraday is revealed and it is the source of much that is included in this paper. His earlier letters to Abbot are particularly intriguing and revealing of young Michael as a teenager. One can scarcely believe that they were written by an erstwhile newspaper boy whose formal education had been so meager. In his very first letter he writes:

> Dear A,
>
> Ceremony is useless in many cases, and sometimes impertinent; now, between you and me it may not be the last, yet I conceive it is the first; therefore I have banished it at this time . . .
>
> I was lately engaged in conversations with a gentleman who appeared to have a very extensive correspondence; for within the space of half an hour he drew observations from two letters that he had received not a fortnight before, one from Sicily and the other from France. After awhile I adverted to his correspondence, and observed that it must be very interesting and a source of great pleasure to himself. He immediately affirmed with great enthusiasm, that it was one of the purest enjoyments of his life (observe, he, like you and your humble servent, is a bachelor). Much more passed on the subject but I will not waste your time in recapitulating it. However, let me notice, b I cease from praising and recommending epistolar correspondence, that the great Dr. Isaac Watts recommends it as a very effectual method of improving the mind of the person who writes and the person who receives. Not to forget, too, another strong instance in favor of the practice, I will merely call to your mind the correspondence that passed between Lord Chesterfield and his son. In general, I do not approve of the moral tendency of Lord Chesterfie letters, but I heartily agree with him respectin the utility of a written correspondence. It, like many other good things can be made to suffer abuse, but that is no effectual argument against its good effects.

> And now, Dear Sir, to conclude in a manner requisite for the occasion. I heartily beg pardon for thus intruding on your time, your patience and your good sense. I beseech you, if you will condescend so far, to return me an answer on this occasion and pray let the refusal of your correspondence be as gentle as possible.
>
> Hoping, Dear A., that the liberty I have taken will not injure me in your good opinion. I cannot conclude better than by wishing you all the happiness you can enjoy, the completions of your good and honest wishes, and full health until I communicate with you again and forever after.
>
> I am Dear A,
>
> Yours Sincerely,
> M. Faraday

It is interesting to note that all the letters of Faraday, even those to his wife, were always signed the same way - M. Faraday - never Michael.

At the end of his apprenticeship in 1812 he became journeyman bookbinder to Mr. De La Roche, a French emigrant and artist, who had once painted a portrait of Napoleon. He quickly grew fond of young Michael and once offered to make him his partner and heir if Faraday would remain with him. Apparantly the fondness was not reciprocal, for Faraday shortly became unhappy as expressed in his letters to Abbot.

With this unhappiness also grew his interest in science. Late in 1812 he wrote to Sir Humphrey Davy, then Director of the Royal Institution which was founded 13 years earlier by Count Rumford to promote research and other activities that would be of value to the poor of England. Accompanying his letter, expressing an interest in a scientific career, Faraday sent a 386 page volume, beautifully made and bound, consisting of notes made of several of Davy's lectures which young Faraday attended earlier in the year. The year before he had written in a similar vein to Sir Joseph Banks, President of the Royal Society, but had received no

answer. Davy was more courteous and was impressed with the volume which he received. He asked Faraday to visit him at the Royal Institution which he did in early January 1813. At this brief meeting Davy strongly advised Michael to remain in the bookbinding and selling trade, since there were few rewards to be obtained in a scientific career. He even offered to send to Faraday for binding any books which the Royal Institution might produce and to recommend him to friends.

A short time later Davy's eyes were injured in an explosion while preparing nitrogen chloride. He sent for Faraday to read to him while recuperating from the injury. This was the chance that Michael was awaiting and quickly gave up a permanent position for a temporary one reading to Davy. After four days he was jobless.

Fortunately for society, some three weeks later Davy was forced to fire his laboratory assistant. Again he sent for Faraday and offered him the vacant position, two rooms on the top floor of the Institution in which to live, and a salary of 25 shillings per week - about one fifth of what he had been making as a bookbinder. Faraday quickly accepted and moved to the Royal Institution where he was to live and work for the next forty-five years - simply and sometimes in near poverty, but always with the intense desire to obtain new knowledge and to gain an understanding of the old. Thus at the age of 21 Faraday immediately began an intense preparation for the remarkable career ahead. Aside from helping Davy to prepare lecture demonstrations and apparatus for new laboratory experiments, Faraday began a careful study of the art of lecturing with the idea of becoming the best lecutrer in all of England. In a letter to Abbot he gave a remarkable critique of a good lecturer which should be read by anyone aspiring to become a great one. By the way, in less than 10 years Faraday was recognized as one of the better ones in the British Isles.

Though England and France were at War in 1813, Davy did get permission to visit France and asked young Michael, who up to this time had not ventured farther than twelve miles from London, to accompany him. They set out in October and spent the next 18 months traveling through Europe visiting scientists and scientific laborato

This proved to be an excellent experience for Faraday as indicated in the letters written to Abbot and others, while he was on the content.

Faraday gave his first public lecture in 1816 before the City Philosophical Society and published his first paper. The years between 1816 and 1820 were devoted mostly to working for Davy and educating himself in chemistry and physics. In 1816 the Safety Lamp for miners was produced, the credit for which went to Davy. It is, however, evident from notes and letters of both men that Faraday should be given major credit for this remarkable invention which saved the lives of so many English miners.

Faraday's career as an independent scientist really began to flourish in 1820 when he initiated his famous work on electrochemistry and electromagnetism; the thoroughness and completeness of which remain to this day a model for scientists to emulate.

In 1823 he was proposed as a fellow of the Royal Society, the only honor, of hundreds which he received, that he actively sought. Despite the stringent opposition of Davy, his friend and mentor, who was then President of the Society, Faraday was elected a year later with only one black ball cast against him - presumably Davy's. After this incident Davy was never again cordial to him.

I should now like to turn to Faraday as an individual, a husband, a devout religious worker, and a philanthropist. It is <u>through</u> a study of these aspects of his life that we may gain a better understanding of what urged this Englishman to greatness, not only as a scientist but also as a human being.

<u>HIS POVERTY</u>

By 1832, when Faraday was 41 years old and quite famous, his annual salary at the Royal Institution was 100 pounds "house , coal and candles". During the years 1824 to 1830 he became much in demand as a consultant and did accept some of the more interesting problems that were brought to him. By 1830 his annual consulting income was about 1,000 pounds. It was then that he made

the decision to stop all work of this kind and devote his total efforts to research.

After one year, i.e. at the end of 1830, his outside income had fallen to 155 pounds. At the same time he gave up all social life except for visits by close relatives and friends and occasional attendance at the theater with Mrs. Faraday. In the next five years he lived in almost abject poverty, spending his meager income on the bare necessities of life and needed equipment and supplies for his laboratory. In 1836 upon the strong urging of friends he accepted a government pension of 300 pounds per year, as was the custom to give in 19th century England to those who distinguished themselves in some way important to the State. Thereafter he lived comfortably and gave all of his excess income to the poor of London.

HIS MARRIAGE AND MARRIED LIFE

In his earlier days as a bookbinder's apprentice Faraday began the keeping of a neat notebook in which he recorded not only his doings but also his every thought. He also early in life established the habit of carrying small cards in his pockets on which to record ideas or thoughts as they came to him. He would stop in the street, or in the middle of a conversation, to jot them down for later transfer to his regular notebook.

Unfortunately for posterity some of these earlier notes have been lost. Others have come down to us intact. Among them are numerous poetic diatribes making fun at love and lovers. In one, for example, he asks "What is Love?" and answers, "a nuisance to everybody but the parties concerned; a private affair which everyone but those concerned wishes to make public".

Faraday once showed these diatribes against love to Edward Barnard, a close friend and fellow churchman, and then years later proceeded to fall in love with Sarah Barnard, Edward's younger sister. Unfortunately Edward told Sarah of the youthful tirades of young Michael. When Faraday paid serious court to her, she asked to see the rhymes against love in his notebook. At this he demurred but in reply sent her a poem dated October 11, 1819, of which I will quote only

three stanzas:

"You asked me last night for the lines which
I penn'd
When, exulting in ignorance, tempted by pride
I dared torpid hearts and cold breasts to
commend
And affection's kind pow'r and soft joys to
deride.

If you urge it I cannot refuse your request;
Though to grant it will punish severely my
crime;
But my fault I repent, and my errors detest;
And I hope to have shown my conversion in
time.

The principle's noble! I need not urge long
Its adoption; then turn from a judge to a
friend;
Do not ask for the proof that I once acted
wrong;
But direct me and guide me the way to amend".

By the way Faraday was a friend of Samuel Taylor Coleridge, who had a high opinion of Michael as a poet. Coleridge once remarked that had Faraday spent his energies and talents on writing poetry instead of on scientific research, he would have been England's greatest poet. Having read a number of Michael's poems I am glad that he confined his attention to science and left poetry to Coleridge and others.

Ten months after writing the poem quoted above, Michael had not won the hand of Sarah, for we have the record of another letter written to her on July 5, 1820. It is a beautiful love letter and so typical of the writer. He writes:

"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 cannot.

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 injury me by withdrawing your friendship, or punish me for aiming to be more than a friend by making me less; and if you cannot grant me more, lveave me what I possess, but hear me".

Even after this Sarah still had fears about accepting her lover and to postpone a decision she, upon advice of her father, left London with a married sister to spend time in Ramsgate, some miles from London. Michael soon followed to press a successful suit; for in his notebook he wrote of his last evening with Sarah:

> "Not a moment's alloy of this evening's happiness occurred. Everything was delightful to the last moment of my stay with my companion, because she was so".

They were married on June 12, 1821, when Faraday was 29 and she was 21.

His marriage, though childless, was a very happy one. He now had the companion and helpmate to continue his life as a "philosopher" as he wished to call himself. He hated the word "physicist", but did sometimes refer to himself as a chemist. Sarah was most devoted to Michael and submerged her life completely with his, anticipating and obeying his every wish.

In my opinion she was responsible in great measure for the extraordinary devotion which he was able to give to his scientific research and thus make his remarkable contributions to mankind. She was particularly helpful to him during his illness, which began at age forty-nine and lasted for four years. During these years he was sometimes quite morose. The loving care which she gave him was no doubt largely responsible for his recovery to make many more important contributions to science.

As for Faraday, he loved Sarah with a chivalrous

devotion that lasted throughout his life as gleaned from the letters he wrote to her when he was absent from London. During the last years of his life, when he realized that death was near, his only expressed regret was that he had not accumulated funds for her support.

HIS ILLNESS

As early as 1831 when he was forty years of age, complaints began to appear in his letters and notes about loss of memory. As he confined himself more to his laboratory and his researches, these complaints increased in frequency. Finally in 1840, at age 49 he was forced to give up all work and take a complete rest for four years. Through the kindness and generosity of friends, Mrs. Faraday was able to take him to Switzerland for a few months, a visit which he seemed to enjoy very much as judged from his letters and notes.

His illness was diagnosed by medical authorities as mental exhaustion from overwork. In the light of more recent medical knowledge, and judging from all that we can learn from his other complaints and from statements of those who knew him, I am inclined to believe that his illness was due to chronic mercury poisoning. For fifteen years prior to his "breakdown" he had spent much time on the liquefaction of gases. In his laboratory were many pumps using mercury. We also know that he used mercury in many other ways. We can presume that much of the metal was spilled in the laboratory and anyone who has done so knows how hard it is to recover. Many small globules of mercury find their way into cracks and crevices in the wooden floors and laboratory benches.

Recent studies have indicated that chronic mercury poisoning can be elicited if one breathes air containing much more than 0.1 mg of the metal per cubic meter. Air saturated with mercury contains about one hundred times this amount. These facts, combined with the various symptoms of which Faraday complained, support the thesis that he suffered from chronic mercury poisoning rather than mental exhaustion. Besides loss of memory Faraday was known to suffer from dizziness, chronic sinus pains, or "Face-ache" as he called them, mental depression, insomnia, stomatitis, loss of appetite, erethism, and

a peculiar form of timidity. The latter was particularly noticeable during his illness. All of these symptoms are now known in persons suffering from mercury poisoning.

Fortunately for science and the world, Faraday made a splendid recovery and, after four years of complete rest, returned to his laboratory to make some of his more important discoveries.

It is interesting to note that Faraday's illness came at the same age i.e. forty-nine, as did Newton's similar breakdown. However, when Faraday recovered, his mind was still as acute as ever. Newton never quite recovered his mental acuteness, and certainly not his prior initative.

HIS RELIGION

Faraday's father, and grandfather before him, belonged to a small religious sect known as Sandemanians. This was a sect founded by John Glass in Scotland in 1730. Reverend Glass was a Scottish Presbyterian Divine who was deposed by the Church Courts in 1728 because of certain views which he held, and attempted to propagate, that were in conflict with the doctrines of the church at that time. Chief among these were:

(1) That the church should not be subject to any covenant but be governed only by the doctrine of Christ - and his apostles;

(2) That Christianity should never become the established religion of any country in view of the belief that Christ came into the world to promote the existence of an eternal life after death and not to establish any sort of world power;

(3) That the Bible, as translated into English, was the source of perfect truth; that man could not add anything or take anything away, but must follow it in every way and under every circumstance.

The sect in Scotland was known as Glasites but Robert Sandeman, a son-in-law of Glass, soon became the spokesman of the group and was responsible for the establishment of churches in several parts of England, including the one in a poor district of London at the end of Paul's Alley off Red Cross Street, to which Faraday's mother and father belonged - thus the designation as Sandemanians.

By the way Sandeman later came to America and settled in Connecticut where he established at least one church. There is some evidence that he also spent some time in North Carolina and Georgia. No churches were established there, but his visits apparently did have considerable influence upon the religious beliefs of a group known as Primitive Baptist that had a large membership in the rural south, particularly in Georgia, during the nineteenth and first quarter of the twentieth century.

The sect was rather exclusive and did not proselytize. They followed simple apostolic practices. On Sunday services began at 11 A.M. and lasted until about one, after which members ate together in a room attached to the chapel, casting lots for a place to sit. Following the meal, services were continued until late afternoon, when the Lord's Supper was celebrated by the washing of each other's feet.

There were no regular ministers and meetings were led by elders elected by the congregation. Elders presided in turn. New members were admitted after a public confession of sin, a profession of faith and a receipt of the kiss of charity.

The saving of money and accumulation of wealth was considered as sins. Members were very charitable and gave generously to the poor.

This was the religious environment in which Faraday grew up. As a boy he attended church with his family, but did not make a public confession and join the church until a month after his marriage. This he did without any discussion with his wife who was already a member. When she questioned him about this his reply was "This is between me and my God".

Faraday was a devout Sandemanian and the doctrines of this sect had a profound influence on his life. The habit of non-proselytization was carried over into his scientific work. He had a very high regard for scientific fact and its power to convince without argument. "Facts speak for themselves" was a favorite expression. He did not try to promote himself and declined to apply for, or accept, certain positions or honors which were urged upon him by his friends.

Because of his great scientific reputation throughout the world, he received more than three hundred honors during his life without any solicitations on his part. He once said to a friend that the only honor which he ever wanted, or sought, was á fellowship in the Royal Society which was granted him in 1825, in spite of the opposition of his friend and mentor, Sir Humphrey Davy. In later life he refused knighthood by the Queen, saying that he wanted to remain plain Michael Faraday. He also refused the presidency of the Royal Society, the highest post that can be bestowed upon a scientist in England. He did accept under some protest an honorary degree from Cambridge.

Faraday held tenaciously to the religious belief of non-accumulation of wealth. Whenever he and Mrs. Faraday collected any sums from his meager salary and government pension, he would visit the poor of London, mostly incognito, having tea with them and giving money or other items to support their needs.

In 1840 he was elected an elder of his church and thereafter preached on alternate Sundays. Apparently he was much less effective as a preacher than as a scientific lecturer, where he was superb. Dr. Bence Jones, who often heard him in both capacities, once remarked that "though no one could lecture like Faraday, many might preach with more effect".

His first sermon as an elder was from Matthew, Chapter 11, Verses 28-30, dilating on Christ's character and example and particularly that passage in which he exhorted his listeners "to learn of me".

Elders were required to attend service every Sunday and Faraday usually interrupted his attendance

at scientific meetings to return to London on Sunday. On one occasion he obeyed, under protest expressed to Mrs. Faraday, a command from the Queen to dine at Windsor Castle. The congregation of the London Church did not consider this an acceptable reason for his absence from services. Both his eldership and membership were suspended. Faraday made no vigorous protest but did attempt to defend his action. He continued to attend service as a non-member but could not actively participate in preaching or in reading the scriptures. After two years he was re-admitted to membership but it was almost 10 years before he was re-elected an elder. It is reported that during his active days as an elder he was called upon almost every Sunday to read the scripture lessons selected by the presiding elder. He was an excellent reader and the congregation enjoyed listening to him. Mr. Walker, a member of the congregation, wrote some twenty years after the death of Faraday: "It was one of the richest treats that ithas been my good fortune to enjoy to hear Faraday read the Bible. The reader was quite unaware what he was to read until the passage was selected and when one chapter of the Old Testament was finished another would be given, probably from the New Testament. Usually three chapters were read, and sometimes four, in succession; but if it had been half a dozen, there would have been no weariness, for the perfections of the reading with its clearness of pronunciation, its judicious emphasis, the rich musical voice and the perfect charm of the reader with his natural reverence, made it a delight to listen. I have heard most of those who are considered our best readers in church and chapel, but have never heard a reader that I consider equal to Faraday. At this distance in time his tones are always in my ears".

In his very prolific writings Faraday seldom mentions religion. Nor washe prepared to discuss it in his conversation with other than close friends. His religious creed supplied him with what he believed to be the proper answer to the perplexing problem of human destiny, gave him a freedom from acquisitiveness and social ambitions and a respect for government and authority. He wasted little, none, of his energies on the acquisition of wealth, on the attainment of social prestige, on opposition to the social injustices of his time, or on the seeking of a safe anchorage in immortality.

There is no question that his religion furnished him with that very detachment which was necessary or essential to his scientific pursuits.

Faraday had a profound influence upon, and was loved by, all who knew him well - scientist and non-scientist alike - including his young sister-in-law, Jane Barnard, who never married in order that she might live with the Faradays to help her sister take care of the man they both loved.

The great scientist John Tyndall, who was thirty years younger than Faraday, a close friend, and his successor as director of the Royal Institution, said of Faraday; "It was my wish to play the part of Schiller to this Goethe; and he was at times so strong and joyful - his body so active and his intelligence so clear - as to suggest to me the thought that he, like Goethe, would see the younger man laid low. But destiny ruled otherwise. He was equally rich in mind and heart. The fairest traits sketched by St. Paul found in him perfect illustration. For he was 'blameless, vigilant, sober, of good behavior, apt to teach, not given to filthy lucre'. He had not a trace of worldly ambitions; he declared his duty to his Sovereign by going to the levee once a year, but beyond this he never sought contact with the great. The life of his spirit and of his intellect was so full, that the things which men most strive after were absolutely indifferent to him. Nature, not education, rendered Faraday strong and refined. By some natural process in the formation of this man, beauty and nobleness coalesced, to the exclusion of everything vulgar and low. He did not learn his gentleness in the world, for he withdrew himself from its culture; and still this land of England contained no truer gentlemen than he. Not half his greatness was incorporated in his science, for science would not reveal the bravery and delicacy of his heart".

Possibly Emerson could have had a scientist such as Faraday in mind when he wrote "Give me health and a day, and I will make the pomp of emperors ridiculous"

Hoke S. Greene