MATERIALS FOR LANGUAGE TEACHING AT RUDOLF STEINER (WALDORF) SCHOOLS

Magda Maier

Michael Faraday

a Scientist in His Time

Edited by Christoph Jaffke in co-operation with the
Pädagogische Forschungsstelle beim Bund der Freien Waldorfschulen
Stuttgart 1991

Acknowledgments

The following institutions have provided illustrations for this book and have kindly permitted their use:

Deutsches Museum, Munich
National Portrait Gallery, London
The British Library, Map Library, London
The Royal Institution of Great Britain, London

Beyond this, I wish to thank several people for their help and the very personal interest they took in the progress of work: Mrs. I. M. McCabe of The Royal Institution, London, Mrs. I. Kürsten of the Deutsche Museum, Dr Hans Rebmann of Stuttgart, and the sharp-eyed friends who went through the manuscript, leaving only those errors which are my own: H. and R. Hauf, Ph. Beital and C. Jaffke, without whose energetic prods the whole venture would have foundered.

Thanks are also due to those classes and their teachers who tried out the manuscript, and to P. Kirk of a Class Nine who helped to throw out the bits that were boring and to change those that were comprehensible only to the author herself!

M.M.

TO THE READER OF THESE PAGES

The biography of a great man is too powerful to put between the covers of a short reader for Class Nine. What seems most interesting at present is to see how a man grew up at a time about two hundred years before our own, how his path led him to be interested in a special aspect of nature, and how he discovered the laws by which others were able to invent many of the machines we live with.

It is important to be able to picture the place where a person grew up and where he worked. Some people cover a great deal of ground in their lives, others remain within a very few miles of the place where they were born. Michael Faraday is one of the latter group. Apart from two visits to the Continent, he hardly left the outskirts of London. Therefore, a chapter on the London scene in Faraday's lifetime seems a useful thing to read before getting hold of the story itself.

The greater part of this book tells you about the early years of Michael Faraday. What impressed me most as I got to know him better was the strength of will that carried him to his work in life, to his true vocation. Research, discovery, and teaching, these were what he carried within him as his very own task. The results of his work are important factors of the world we live in.

There are also a number of chapters devoted to people who were important in his life. You will find them in the appendix, and some of you may want to read them and tell the rest of the class about them. You may even get the feeling that these people seem more important than the "hero". But that, of course, is so in all real lives. None of us can do what we set out to do without the support of other people who are close to us.

The chapters on some of Faraday's discoveries will give you a great many new words that we need in order to grasp the modern world, and to find our way about in it, words about electricity, and words for the apparatus that Faraday needed to make his experiments. His decisive discovery was the relation between magnetism and electricity. All of you know that our

modern lives would be impossible without the dynamo, the electro-motor and all the other things that stem from his discoveries. It is interesting that he was really a discoverer rather than an inventor. Other people went on to make the practical inventions that arose from the insights he won. – Of course, we shall also read about "Faraday's Cage", which many of you may already know from the model that can be seen in the "Deutsche Museum" in Munich. We shall not, however, go into all the fields that were studied by the great scientist. You are sure to work at them in Classes 11 and 12.

There will be one chapter towards the end of the reader in which we see Faraday as a middle-aged man in a very trying situation. We shall also see how much had to happen from all sides for him to find help.

By this time, you will probably be interested in words from Faraday's last lectures given to London children near the end of his life, in 1860/61.

You will not find much conversation in the book. I think that this part of the work is best left to the reader. If the situation is plain, what people say in it is really a matter for the imagination. I should be very pleased if some of you finally turned this biography into a series of dramatic scenes and went on to act them.

After all, the most important thing anyone can do in order to learn English is – to talk!

SOME OF THE PEOPLE WHO WERE IMPORTANT TO FARADAY

Mr Riebau, a bookbinder to whom Faraday was apprenticed

Mr de la Roche, another bookbinder in whose workshop Faraday worked as a journeyman

Huxtable and *Abbott*, his friends

Mr Magrath, a member of the City Philosophical Society in London

Mr Dance, a member of the Royal Institution

Mrs Jane Marcet, woman author of a book on chemistry

The Count "von" Rumford, an American-born all-round genius, who founded The Royal Institution in 1799

Sir Humphry Davy, the world-famous scientist who made it possible for Faraday to take up science as his career

Sarah Faraday, née Barnard, who became Faraday's wife

WHAT CHANGES DID FARADAY BRING ABOUT IN THE WORLD?

We read these lines in houses lit by electricity. Many of us have meals cooked on electric stoves and kept cool in refrigerators. We travel by electric trams and suburban railroads. We ring up our friends on the telephone. We listen to the radio. We wear clothes spun, woven, cut and sewn on machines powered by electricity. Above all, we are ready to take all this as a matter of course, as if electric current were simply a part of nature that had always been "laid on", as if it had been at our service from the beginning of time. But we all know that not very many generations ago, the working of this tremendous force of nature was a mystery to mankind. The idea of producing it and harnessing it to our everyday needs was far from even the most adventurous minds.

The man whose life we shall get to know was someone whose power of imagination was so strong that he was able to give us a new picture of the forces in the midst of which we now lead our daily lives. He was able to show the relation between magnetism and electricity in such a way that others, after him, were able to make important practical inventions such as the dynamo and the electro-motor. He was also concerned with many other questions which you will study in the physics courses of Classes Eleven and Twelve. He even began to ask himself questions about the forces that held matter together.

In other words, he was never too sure that what he and others had thought was the last word on a subject. He was always ready to learn something new. He lived during a time when the War of Independence in the former British Colonies, the French Revolution, and the rise and fall of Napoleon had changed the political face of Europe and, indeed, the world. But above all, he lived in a world in which the Industrial Revolution gradually brought about changes in people's every-day lives, until, to-day, each of us is surrounded by a web of machines whose services we take for granted, and on which we are entirely dependent in the way we have arranged our lives. All this did not come

to pay the usual fee to the stationer. This meant that Michael was taken into the master's family. He was given somewhere to sleep. He shared the meals of the master, his family, the journeymen and the other apprentices. Of course, on his various errands, the boy would look in at the smithy from time to time, but he was too dutiful to linger for any length of time, knowing that Riebau had work waiting for him at home.

The blacksmith died in 1810, when Michael was almost nineteen, and the older brother, Robert, who had learnt the trade from him, now had to take over.

A BOOK THAT MADE A DEEP IMPRESSION

Nowadays we walk into a bookshop and simply take a book from the shelf, go to the cashier, get our bill and pay. All we have to decide is whether we'd prefer a hardcover or a paperback. That's why there are not nearly so many bookbinders today as there were then. In Faraday's time, you ordered an unbound book. That is to say, you just bought the pile of printed paper that was folded but not even cut open. Then, depending on your means and your taste, you had it bound in leather or linen, and chose the colour of the binding so that it would match the rest of your books. We take machine-bound books to be the general rule, although a great deal of the work is still done by hand.

After Faraday had been apprenticed to Riebau for quite a considerable time, he was asked to bind a new book bearing the impressive name of "Conversations on Chemistry intended more especially for the Female Sex" and written by a Mrs Marcet.

This book was published in 1806, when Michael was just fifteen years old, and we can imagine that the apprentice spent rather more time on his work than usual – after all, the subject took more than just one night's reading! This book seemed to him to open up a new and unexpected world. Indeed, it had that effect on many of its young readers, for it continued on the

market until the middle of the nineteenth century in a great many editions.

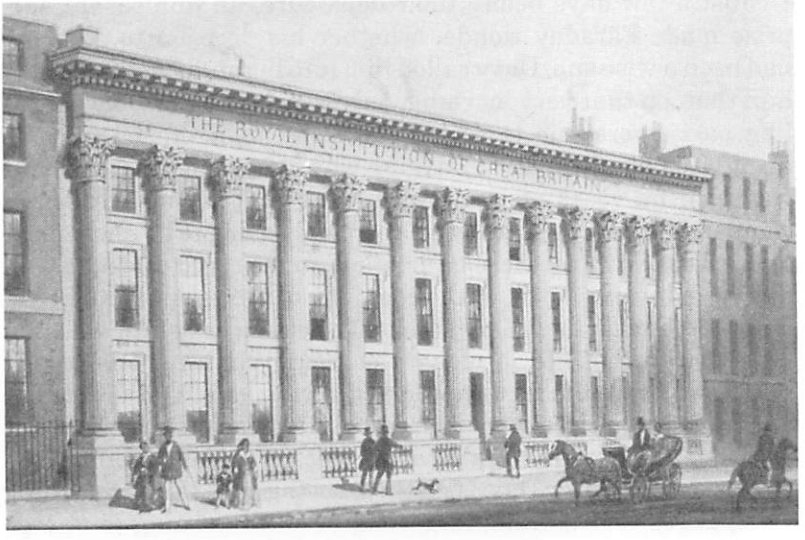
The young bookbinder tried out many of the experiments that Mrs Marcet had recommended. But of course the greater part of his energy was devoted to the work Mr Riebau gave him. He worked in a tiny box-like room to the left of the door and gradually became more and more skilful as a craftsman. So, he once had to bind the entire first edition of the Encyclopaedia Britannica. Its pages drew his eyes to all kinds of information about the world around him. He recollected later that all this happened at a time when he was just as ready to believe in the stories of "A Thousand and One Nights" as he was ready to believe in the Encyclopaedia. Sometimes he felt like a dry sponge, greedily soaking up everything that exercised his thoughts and his imagination.

When he came to the article headed "Electricity", he was quite fascinated. He was determined to try out the experiments for himself. At an old rag shop in Chesterfield Street, he saw two old bottles in the window, right in among all kinds of rubbish. One of the bottles was priced at six pennies, the other at only one penny. Every day, he walked past the shop in order to see whether the bottles were still there. At last he was able to scrape and scratch together all that huge sum of money. He converted the first bottle into an electrical cylinder, the second into a Leyden jar. He used a bullet and a piece of wire as conductors. Riebau was quite speechless to see what his apprentice was at. But he must have been used to his "young fellows" being interested in all sorts of things outside bookbinding. One of the boys apprenticed there in Michael Faraday's time became a comedian, another was later a well-known singer.

Faraday was always grateful for the awakening of his own interests and abilities that was caused by these books. Many years later, he remembered how he had met Mrs Marcet for the first time. It was wonderful for him to be able to thank her. She had shown him the way to his future field of work, and his spirit had immediately recognised it as its own. Until her death, he regularly sent her copies of all the books and papers that he published.

has been important in the world of studies and research in England to speak what was then called "the King's English". And so all of them were intent upon speaking as if they, too, had visited well-known schools or even universities.

Watching the professors he had to assist, Faraday learnt a great deal about the methods one should use and those one should avoid. "A lecturer should appear easy and collected, undaunted and unconcerned. He should have his thoughts about him and his mind clear, free for the contemplation and description of his subject. His whole behaviour should show respect for his audience, and he should in no case forget he is in their presence." When he assisted at demonstrations and experiments, it was said that the lecturer was walking "on velvet carpets", so well had Faraday prepared everything that the speaker might possibly need.



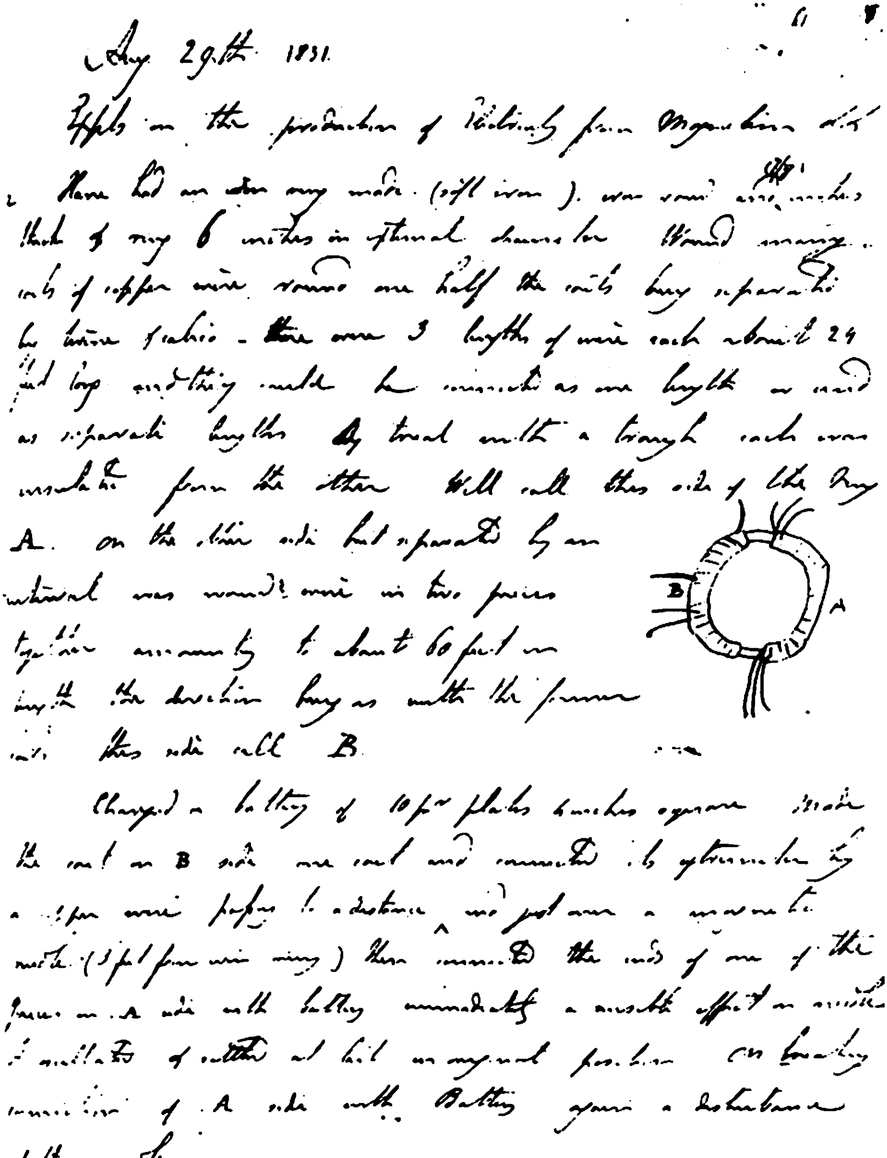
The Royal Institution

TRAVELLING THROUGH EUROPE IN THE WAKE OF A FAMOUS MAN

Faraday had never been more than twelve miles out of London. We can imagine what a surprise it was to him when Humphry Davy asked him to accompany him to the Continent. He needed an assistant for chemical and physical experiments. The whole expedition was to be undertaken in a private carriage and to take about two and a half years. It was not the aim of the journey to see the sights, but to visit famous scientists all over southern and western Europe. In the days before our modern media of communication, travelling was the only way you could come into contact with the top researchers. It was going to be a social journey as well. Lady Davy, who spoke French and German, would be travelling with them.

Just a few days before their departure, an unpleasant surprise made Faraday wonder whether his decision to go along had been a wise one. Davy called him into his study and informed him that, on that very morning, only two days before the travelling party were due to set off, his valet had refused to come along. It is not difficult to imagine why. After all, the Continent was torn by years of warfare towards the end of Napoleon's campaigns. And the journey was certainly going to be uncomfortable, cramped in the close quarters of an overland coach, travelling from town to town, in the company of the scientist, of proud and overbearing Lady Davy and of the young assistant who had no experience of life in elegant society. Whatever the reason may have been, the fact remained that the valet had decided to quit without notice. Davy now asked Faraday to serve him not only as an assistant but also as a valet, as a manservant. That meant looking after Davy's clothes, seeing to it that everything was packed and nothing forgotten, as well as being in charge of all the apparatus they carried with them for demonstrations and for scientific discussion. For Lady Davy, a temporary woman servant was to be engaged in every place they stayed at.

Faraday agreed. On the journey, there must have been many moments when he regretted this decision. Although Sir Hum-



Aug 29th 1831.

Expts. on the production of Electricity from Magnetism, &c. &c.

1. Have had an iron ring made (soft iron), iron round and 7/8 inches thick and ring 6 inches in external diameter. Wound many coils of copper wire round one half, the coils being separated by twine and calico — there were 3 lengths of wire each about 24 feet long and they could be connected as one length or used as separate lengths. By trial with a trough each was insulated from the other. Will call this side of the ring A. On the other side but separated by an interval was wound wire in two pieces together amounting to about 60 feet in length, the direction being as with the former coils; this side call B.

Charged a battery of 10 pr. plates 4 inches square. Made the coil on B side one coil and connected its extremities by a copper wire passing to a distance and just over a magnetic needle (3 feet from iron ring). Then connected the ends of one of the pieces on A side with battery; immediately a sensible effect on needle. It oscillated & settled at last in original position. On breaking connection of A side with Battery again a disturbance of the needle.

Laboratory Diary, Aug. 29th 1831,
describing the discovery of electro-magnetic induction

Looking at a model of the apparatus he used, one is struck to see how carefully the fine strips of silk cloth are wound round the copper wire. It is almost impossible to imagine the extremely hard work that went into every detail of the apparatus. The fine silk material must first have been cut into thin strips, which were afterwards sewn together or joined in some other way. Then it could be wound round the wire, always being pushed together so that it should not slip from the smooth metal surface. Later, silk threads were spun round the wires in order to insulate it. One wonders whether Sarah made herself useful to her husband and insulated the wires for him, or whether there were already people whose job it was to do this.

Straw, chinaware, sealing-wax, and other non-conducting materials all found their way into the apparatus the scientists constructed. Occasionally, one could not be quite sure whether the result of an experiment was not really influenced by some peculiarity in the materials in which it was set up.

The experiment described by Faraday was repeated with a straight bar of iron, and the same result came about. Whenever the current was switched on or off, the electric impulse was induced in the coil unconnected with the source of the electricity. This phenomenon of induction became the basis by which all dynamos work. The actual development was taken up the very next year by another scientist. In a tremendous whirl of activity in many countries, it passed through a great many heads and hands from science to technology. Faraday himself followed up these experiments with others, all connected with electricity, until he wrote to a colleague in Berlin that he was feeling quite hungry for a little chemistry! He did, however, go on to say that whatever the individual direction of one's research, it would always bring one to the eternal laws where we would all meet at last, able to admire and enjoy the wonders of the world.

Channel from the Napoleonic Wars. He died in London in 1822. Mrs Marcet spent many of her widowed years teaching and especially writing. Her "Conversations on Political Economy" had just been completed at the time of the downfall of Napoleon and interested many people, such as the British writer and politician, T.B.Macaulay. Jane Marcet stayed in London all her life, and saw many changes come over the land, perhaps the most important being the gradual rise of the British Empire. There was another thing that probably interested her still more. That was the Reform Bill of 1832 that gave many people the vote. From then on Parliament played a much more decisive part in political affairs. It took three more generations for this right to be given to women. In Jane Marcet's day, most people thought it was impossible for women to have political ideas at all. She herself was one of the independent women who proved that such thoughts were entirely wrong.

II

THE FOUNDER OF THE ROYAL INSTITUTION

Sir Benjamin Thompson, Count von Rumford
(1753 – 1814)

The life of Benjamin Thompson spans a great part of the world of that time and he made himself at home, one feels, wherever he was. In North Woburn, Massachusetts, where he was born on March 26,1753, things did not look very fortunate. His mother came from a family that had been in the Colonies for several generations, since 1630. She was the daughter of an officer of the British Army who fought against the French and the Indians in the Seven Years' War. Only twenty months after Benjamin's

birth, his father died, and so he was brought up by a stepfather. First, Benjamin was sent to the village school, then to a nearby town school, being especially interested in maths, mechanics and 'natural philosophy', as natural science was called at that time. He began to experiment very early, in 1769 endangering his life when he involved himself in fireworks of various kinds. By that time, he was already working for a shopkeeper in Salem, the capital of Massachusetts. He grew to be six foot tall and was a very handsome, striking young fellow. Soon, Salem seemed too stick-in-the-mud for him, so on he went and found employment in Boston. The subjects he wanted to study in his spare time show that he had not really made up his mind in any definite direction. He tried French – which later turned out to be very useful to him. He fancied medicine might be an interesting subject to study, and the beginnings fascinated him. In order to have enough exercise, he also learnt to fence. So he became a very accomplished young man.

But things became more and more difficult for people in the colonies during the conflicts with the motherland, especially over taxes. Little by little, business came to a standstill. The next job Benjamin Thompson found was that of a schoolmaster, hired by a wealthy family in Rumford, New Hampshire. This town later became famous in American history by the name of Concord. At last, everyone felt Benjamin had made his fortune. He married a relative of the family he worked for, a widow eleven years older than himself. He had indeed made his fortune. but this soon took him far away from Mrs Thompson. It was through her that he had met the British Governor of New Hampshire, who was most impressed with his knowledge of chemistry, took him into the Army as a major, and let him make as many gunpowder experiments as he liked. As Independence neared, he found he was criticized for his attachment to the British. A short term of imprisonment for insufficient support of the strivings for Independence convinced him that his place was not with the colonials. Leaving his wife, he set out for England, where he soon made influential friends in the London Colonial Office, even being sent back across the Atlantic to fight the "rebels". During that period he got increasingly involved in observations,