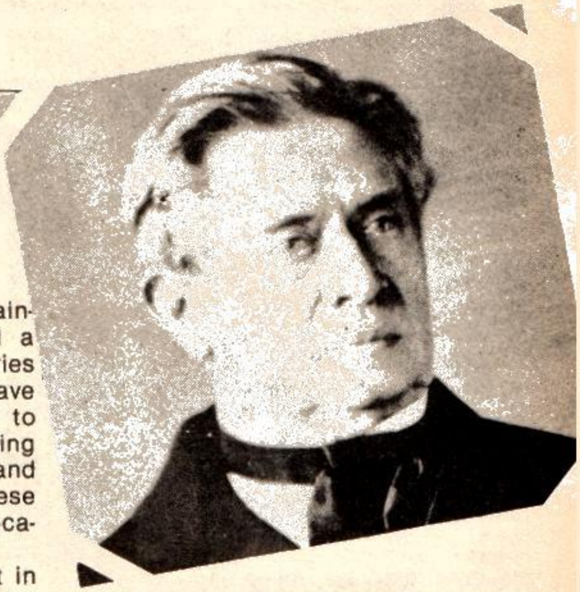
Henry

This month we look at the life of Joseph Henry, whose name is associated with the unit of inductance

Pioneers of Electronics Series



WE'VE BECOME quite accustomed in this century to remembering the names of famous people of the past by using these names for measuring units or instruments. This way, even though you may have only the faintest notion of who Ampere, Ohm or Volta were, you can't escape the familiarity of the names. Nevertheless, some names are not so well known as others, and Joseph Henry must rank among the names which very few of us would recognise except as the name of the unit of inductance.

Perhaps part of that unfamiliarity is because Henry was American, and he worked on many of the projects which, were the province of Michael Faraday. The two men were, in fact, very often engaged in the same line of research at the same time but, because of the poor communications of the time, were unaware of each other's work. That'll teach us to complain about second-class post!

Let's start at the beginning. Joseph Henry, who was born in 1797, is regarded as the second most outstanding US scientist, taking second place only by a whisker to Benjamin Franklin. Let's see if we can catch some flavour of what he contributed to our knowledge of electricity.

Choice For Life

Joseph Henry intended to study medicine when he went to Albany Academy in New York in the 1820s, but medicine was a science in its infancy and Henry caught the excitement which surrounded the study of electricity. In 1825 he abandoned medicine and changed to a course of practical science, which we would now call engineering. He was brilliantly successful, and in 1826 was appointed to teach Mathematics and Physics at Albany Academy. This was a wise choice, both for him and for the Governors of the Academy. In Joseph Henry, Albany Academy gained an outstanding teacher and a brilliant scientist. Few discoveries have ever been made which have come as a complete surprise to anyone with a really good grounding in Mathematics and Physics - and there is nothing better than these subjects today to ensure an education which will set you up for life.

His work began to bear fruit in 1829. Until that time, electromagnets had been made by winding bare wire onto insulating formers which were threaded to ensure that one wire could not short against the next - we still wind coils for shortwave receivers this way. Henry demonstrated that by using insulated wire and by winding it closely, layer over layer, he could greatly increase the lift of an electromagnet. He proved the point by constructing a magnet which could lift nearly a ton, and gave it to Yale University.

Electromagnetism naturally led to the idea of generating continuous movement by using electricity, and to a form of electric motor in 1829. This was eight years after Faraday had first demonstrated the possibility of causing continual motion by using magnetic forces, but Henry's motor was a much more practical affair, quite capable of being built in larger form to drive machinery, as indeed it soon was.

Early Telegraphy

By 1831 Henry was working alongside another famous scientist, Samuel Morse. Their task was the development of the electric telegraph, the invention which, along with the railway, was to open up the West and spread law and civilisation. The telegraph was the start of communications as we know them today. It's difficult for us now to appreciate what this must have meant in an age when the fastest communication between points too far apart to see was by a man and a horse.

The telegraph was initially a very simple device, consisting of an on/off key at one end and a current-detector at the other, with lots of wire in between. The effect of all the wire in between was one of the problems which Henry decided to tackle. In practical terms, the greater the distance between two stations on the telegraph, the slower the operator had to transmit. If he didn't slow down, the receiver did not indicate a clear-cut dot or dash, up to the point where it might even have stopped moving altogether.

In 1831, Faraday had discovered electromagnetic induction. If you move a magnet near a wire, a voltage appears between the ends of the wire while the magnet is moving. Henry took up this idea, and reasoned that physical movement was not necessary, only a change of magnetism. When a current starts flowing through a wire, there must be a change of magnetism from zero (no current) to whatever amount is present when the current reaches its full value. This change of magnetism, Henry reasoned, should also cause a voltage to be induced in the wire - the same wire! He realised further that this induced voltage would oppose the current and try to stop it from increasing. It was this opposing voltage which was causing the odd effects on long telegraph lines, and the effects could be much more conveniently studied by winding the long wires onto electromagnets. Henry looked at some of his old electromagnets, and made measurements of the voltage across the terminals when the current through the coils was changed. He found that for a given shape of magnet, with a set number of turns, the ratio:

$$\frac{\text{voltage across terminals}}{\text{rate of change of current}}$$

was constant.

This constant quantity had no relation to the DC resistance R of the wire. Henry called the quantity 'self-inductance', and another of the essential quantities of electronics was born.

In the same year of 1832, Henry was appointed Professor of Physics at the College of New Jersey - now Princeton University. Some idea of the breadth of his ability may be judged from the subjects he was expected to teach as well as Physics - Maths, Chemistry, Minerology, Geology, Astronomy and Architecture!

Mutual Inductance

He continued his research, looking now at the transformer effect in the light of his discovery of self-induction. He soon discovered what had been observed by Faraday earlier. If two separate coils of wire are wound around a ring of iron (an arrangement we now call a toroidal transformer, and treat as if it had just been invented!), then a change of current through one coil causes a voltage across the other for as long as the current is changing. Once again, Henry made measurements, and showed that the ratio:

$$\frac{\text{voltage across second coil}}{\text{rate of change of current through first coil}}$$

was a constant for a given transformer. He called the quantity mutual inductance, so providing constructors of transformers with a method of measuring the 'goodness' of their construction. It was hardly surprising, the that the units of both self-inductance and mutual inductance were to be called Henries, in his honour.

Early Radio?

The days of his great discoveries were almost over, for by this time Henry was a senior scientist devoting his life to bettering science education, but one curious little experiment makes us wonder what might have been. He described coiling a wire around a needle, attaching one end of the coil to earth, and the other to a wire (we would call it an aerial) held up by a kit (see Fig. 1). After a lightning-flash some eight miles away, he found that the needle had become magnetised. This was probably the first recorded action of radio waves — he might so easily have gone on to see if the needle would also have become magnetised by a spark generated at a distance by a battery and a coil!

By the time he died in 1878 Henry had achieved all this, and just as important, served as the first secretary of the Smithsonian Institute. The Smithsonian was the agency by which US Government money could be channelled to support scientific research, the start of the process which put a man on the moon and which made the US the predominant force in world technology.

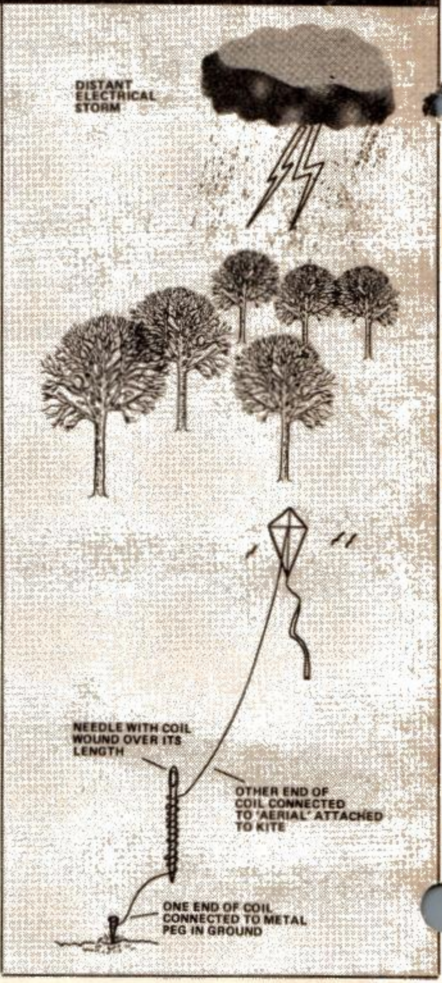


Figure 1. Henry's experiment where a needle, with a coil of wire wound over its length connected to an 'aerial' and 'earth', became magnetised by the electromagnetic radiation from a distant lightning flash.