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JOSEPH HENRY

Physics

Have you ever asked your pupils the question, what American has contributed most to the development of electrical science? Very likely a great majority would answer without hesitation, Edison, the inventor of the incandescent light. Some might answer, Bell, the inventor of the telephone. A few, the radio fans, might say De Forest, the inventor of the three electrode tube. An occasional one might even answer Franklin, the first great American scientist, who drew electricty from the clouds, and showed that lightning and the "electric fluid" are the same. Not one, I am sure, would ever mention Joseph Henry. Perhaps few would even have heard his name. And yet Henry is one of the few American scientists who have achieved world wide distinction in their own life time, and an unquestioned place in history among the great names of science.

Henry was born in Albany, N. Y., in 1799. Little is known about his parents. His father died when he was but a few years old. Educational opportunities for the common people were very meager in those days, and Henry's situation did not enable him easily to take advantage of even such as were available. He studied in night school, and at fifteen years of age was apprenticed to a silver smith. A little later, when his employer failed in business, young Henry entered the Albany Academy as a student. He was not much interested in his studies, however, and was not particularly successful. He had a fondness for dramatics, not then taught in the schools, and an ambition to excel as an actor and dramatic writer, in both of which fields he had excellent ability. About this time Gregory's lectures on Experimental Philosophy fell into his hands. According to his own statement the perusal of this pamphlet thrilled him, opened an unknown world to him, and completely changed the course of his life. He determined thenceforth to give his entire time to the pursuit of knowledge.

In 1826, after distinguishing himself as a surveyor, Henry became Professor of Mathematics in the Albany Academy. Here he taught seven hours a day, and so had time for little else. However, he succeeded in summer vacations in making original investigations in science. His first important work of this character was the development of the electro-magnet, which had previously been invented by Sturgeon, in England. Sturgeon used copper wire wound in a spiral on a varnished iron bar bent in the form of a horse shoe. With this arrangement he succeeded in lifting weights of about nine pounds—twenty times that of the magnet itself. Henry introduced two important variations. First, instead of insulating the bar with varnish he insulated the wire with a covering of silk. This enabled him to wrap the wire around the bar in a closer spiral, more nearly transverse to the bar. Secondly, he wound the coil as a spool of several layers of wire, thus greatly increasing the number of turns. By this type of magnet he was able to raise weights in excess of three thousand pounds. By the current from a single primary cell whose plates were no larger that the hand he raised a weight no less than fifty times that of the magnet itself.

Henry believed that by means of such magnets as he had devised large mechanical effects could be produced at a considerable distance from the battery supplying the current. He thought of the magnets especially as a means of sending signals—as a telegraph. Wheatstone, in England, also believed this possible, **if the power of the electric current did not diminish with distance from the battery.** When this was found to diminish, and very rapidly, with distance, he declared the project hopeless. By placing in the main line a magnet with many turns of fine wire and using this merely as a means of closing a local circuit in which there was a magnet of a similar number of turns of heavy wire Henry promptly succeeded in transmitting effects to considerable distances—doing just the thing that Wheatstone had declared impossible. In this experiment Henry had the exact arrangement of relay and sounder that is now universally used in telegraphy. Had he consented to apply for a patent, as his friends urged him to do, little if anything would have been left for Morse a few years later. Henry, and not Morse, was the real inventor of the telegraph .

In his earlier investigations Henry was working with the effect of an electric current in producing magnetism. The converse question was also raised, could magnetism produce electricity? By wrapping a bar of soft iron with several turns of wire whose ends were connected to a galvanometer forty feet away, placing the bar as an armature across the poles of one of his horseshoe magnets, and turning on the magnetizing current, he observed an effect in the galvonometer. The answer came. Electrical effects can be produced by magnetism. Henry was not the only one who had asked this question. Faraday, in England, was working on it at the same time. Indeed, it is to Faraday that the credit for this discovery is given, not because of priority of discovery, for it is not unilkely that Henry had preceded him in this, but because of priority in the publication of his results.

Another principle which each of these investigators discovered independently was that of self induction. In this Henry preceded his English rival both in discovery and in publication, and is given the undisputed credit. In recognition of his work in this field the International Congress of Science gave the name Henry to the unit in which both self and mutual inductance are measured.

Henry was called to a professorship at Princeton in 1832. For the next fifteen years he worked assiduously both as a teacher and as an investigator, continuing the researches already begun at Albany and adding many others. In 1847, he was chosen secretary (the chief administrative officer) of the newly established Smithsonian Institution. In this position he had little opportunity for research, but spent his energy in shaping the policies of the new institution and applying its funds in the manner best calculated to carry out the purpose for which it was founded. After thirty years of distinguished service as secretary, Henry died in 1878, recognized throughout the world as one of the greatest scientists of his time.

A list of Henry's scientific papers, published in the Smithsonian Institution Reports for 1878, included no less than one hundred fifty titles. These were articles of various length and importance and represented that portion of his great contribution to science resulting from his own researches. The most important among these were the following:

1. The magnetic effect of an electric current.—(The electric magnet.)
2. The telegraph.
3. The electric effect of a varying magnetic field. (The basic principle of the dynamo, the transformer, and the telephone receiver.)
4. The electric motor.
5. The oscillatory nature of the discharge from a Leyden jar or other condenser. (An indispensable principle in present day radio.)
6. Phosphorescence and its cause. (Ultra violet radiation.)
7. The relative temperatures of different parts of the surface of the sun, especially sun spots and the adjacent areas.
8. The conservation of energy.

Henry's interests were those of the research worker rather than the engineer or inventor. When he had made a scientific discovery he was content, always willing to leave the development of practical devices and the monetary reward to others. And it was this singleness of purpose, this concern for the increase and dissemination of knowledge above everything else that enabled him to make so great a contribution to science, and through it to industry and to human welfare.

W. H. Kadesch.

CHEMICAL LECTURE EXPERIMENTS

Chemistry

Lecture experiments demand more time, require higher technical skill, and afford greater pupil interest than any other phase of chemistry teaching. As a corollary, we may add that they are most neglected, but if you name the teachers who are noted for their interesting, instructive, and skillful class room demonstrations, you are calling the roll of chemistry teachers of the first rank.

The first problem is selection. In this connection ask yourself, is the experiment instructive? An occasional spectacular experiment may be introduced for its elements of variety and surprise, but such fireworks must not become the "whole show". Indicate in advance what the experiment is to illustrate; and do not select several experiments which deal with the same point. As far as possible, let the class demonstrations represent ideas which cannot be conveniently handled in routine laboratory experiments.

Next to consider is assembly of apparatus. A chemistry teacher could profit by a course in commercial window trimming. He would learn to stress "key articles," to avoid elaborate and complicated arrangements, and above all, to make the layout look right from the sidewalk point of view. Every article should be in full view, every process should be on a sufficiently large scale as to be visible from all occupied seats, and every manipulation should be so deliberate as to be easily followed. Clean and polished articles, orderly and convenient arrangement on the desk, and scientifically looking setups—all add consciously or unconsciously to the favorable impression which the teacher is seeking to create.

Excepting time-tried experiments in the hands of an experienced manipulator, a rehearsal "behind the scenes" is as important in this field as in the realms of dramatics. An apparently simple experiment may fail to behave as it should unless the details have been carefully worked out by this preliminary rehearsal. Let us assume that th experiment has been moving along nicely toward the climax and that the class is keyed up and expectant—then it fails. Excuses and explanations cannot subtitute for results. Better, far better, never to have tried than to have tried and failed.

Finally, the necessity for motivation should not be overlooked. By skillful questioning, seek to have the class anticipate and suggest the successive steps in the procedure. Encourage them to explain the phenomena as they develop. Use the blackboard for recording the equations involved, the laws and ideas illustrated, and the conclusions which can be arrived at. When desirable, pass samples of the reactants and resultants around the class.

Unfortunately, few, if any, good reference books on lecture experiments are available. The writer would be willing to list for you such as are on the market or even to send you a description of lecture experiments to illustrate definite topics if the demand warrants preparation of mimeographed copies.

Remember that the permanency of pupils' impressions increase in the order,—reading, seeing, doing.

R. W. Getchell.

The "male-water-sheep" which turned out to be a hydraulic ram may after all have its biological affinities. At any rate, Professor L. L. Huber of Hanover College, Indiana, keeps the ball rolling by pointing out that the hydraulic ram is the best source of "steel wool". He does not, however, designate the shearing season.