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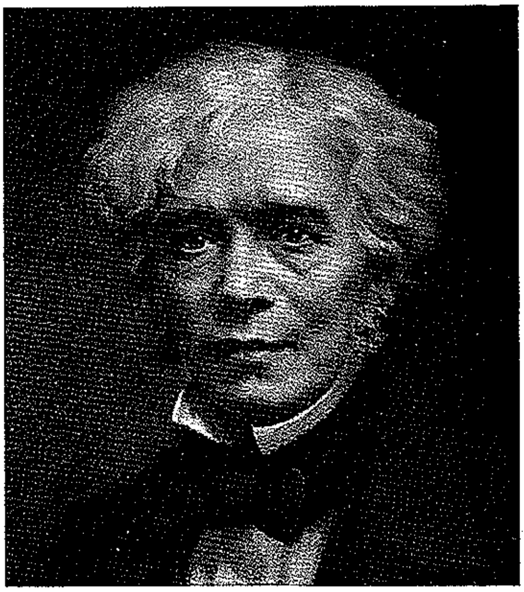
1981...

A year of anniversaries

The year 1981 marks several important anniversaries for the electrical world —the 150th anniversary of Michael Faraday's discovery of electromagnetic induction on the 29th August 1831; the centenary of the world's first International Electrical Congress in Paris in 1881 where the first international agreement was reached on electrical units; and the 75th anniversary of the constitutive meeting of the IEC in London.

The "IEC Bulletin", in this special anniversary issue, pays tribute to Faraday, reports on that important 1881 International Electrical Congress, and describes the initial steps taken by the world's leading electrical engineers of the time in founding the IEC.



Michael Faraday (1791-1867)

Faraday's discovery was the breakthrough for modern-day electricity. His discovery of electromagnetic induction in 1831 made possible the conversion of mechanical power into electricity and opened the way to the transmission of energy over a distance through conductors. This, and this alone, provided the basis for an electricity supply industry and the creation of a manufacturing industry for the provision of dynamos, motors, cables, switches, lamps and other equipment needed to exploit the discovery. For his work, Faraday was to be heralded as the "greatest experimental philosopher the world has ever seen".

Faraday's pioneering work underlines an important aspect of the electrical industry—its international nature. Almost from the start, the progress of electrical science has been the result of an international pooling of knowledge enabling successive generations of scientists to create a further surge of progress. Faraday was no different, for in the 1820s, his own ideas were influenced by the work of others who were exploring electromagnetism.

For example, an important observation was made by a French professor of physics, François Arago, who noticed that the oscillations of a pivoted magnetic needle became sluggish when brought near to a sheet of copper. Arago also discovered that a metal disk, when rotated, would pull a nearby magnetic needle around with it.

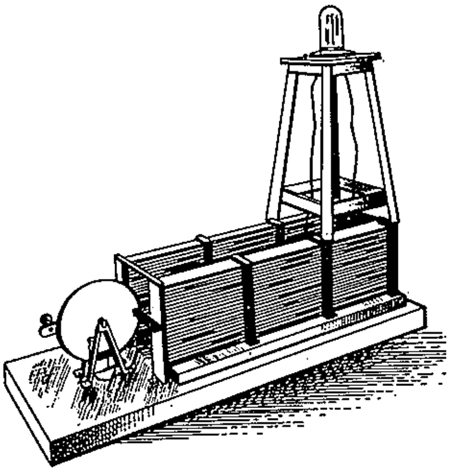
The 1820s also saw a German, Johann Salamo Christoph Schweigger of Halle, repeat Ørsted's experiment and who found that the reaction of the needle could be doubled if the current-carrying wire itself were doubled so that it passed back under the needle. He reported that the effect on the needle increased in direct relationship to the number of times the wire made the double turn over and under the needle.

Then in 1825, William Sturgeon of Britain produced the first electromagnet for practical use as distinct from Ampère's laboratory apparatus. It consisted of a piece of stout iron wire bent into the form of a horseshoe. The wire, coated with insulating varnish, was bound round with 16 bare copper wires, the turns being separated from each other. When the current from a single voltaic pair of 130 square inch plates in acid was passed through the winding, the magnet held a weight of nine pounds—a staggering performance at the time.

In following all these developments, Faraday also benefited from Humphry Davy's interest in electromagnetism. Two curious effects that Davy called to the attention of Faraday (who at one time was Davy's assistant) were that a copper wire carrying a current would pick up iron filings, and that a wire carrying a current would be attracted or repelled by a magnet.

Faraday became more and more fascinated by the possibility of producing an electric current from a magnet. By late 1831, he had successfully completed his two most outstanding experiments.

The date of his first breakthrough in solving the problem of converting magnetism into electricity was the 29th August, 1831. On that day, he took a soft iron ring $^7/_8$ of an inch thick and 6 inches in external diameter, and around one-half of the



Forerunner of the modern generator, Faraday's dynamo was the first machine that could convert mechanical energy into electrical energy by electromagnetic means

ring's circumference (which he called Side A), he wound three coils of wire. Each winding had 24 feet of wire with the turns in the winding separated by twine and calico. Leaving a separating space between the two sides of the ring, he wound the other half (side B) with 60 feet of wire in two separate coils. This original ring, the forerunner of the modern electrical transformer, is now among the treasured exhibits at the Royal Institution in London.

Having prepared the ring, Faraday connected the two coils on the B side in series and carried the connecting wire over a magnetic needle. Then he connected one of the A side coils to a battery. When he closed the battery circuit on side A, the magnetic needle on side B was deflected, oscillated, and then quickly returned to its original position. Faraday observed no further effect on the needle until he broke the battery connection when there was a further kick of the needle but in the opposite direction.

The absence of a permanent current in the "secondary", while the current in the "primary" was still flowing, was of great disappointment to Faraday. For weeks he tried every possible variation in the assembly of this apparatus.

Eventually, he replaced the wound-iron ring by a solenoid—a cylinder formed by the windings of eight lengths of copper wire, each 27.5 feet long. All eight windings were connected in parallel to a galvanometer. He then thrust a cylindrical bar magnet into the solenoid and produced an immediate deflection of the galvanometer needle. When he left the magnet in the solenoid, the needle returned to zero. But when he withdrew it, he produced a second deflection but in the opposite direction. This experiment, made on the 17th October 1831, proved that current resulted from the relative motion of a conductor and magnetic field. The device he had assembled to perform the experiment was the forerunner of the modern electric generator.

The second of Faraday's great experiments concerned the production of a steady current. To produce the necessary motion involved in generating a current, Faraday arranged a copper disk on a brass axle for turning. Wires, in rubbing contact with the edge of the disk and the axle, were connected to a galvanometer and the disk was placed so that its outer edge rotated between the two poles of a horseshoe magnet. His first experiments failed, but when the disk was rotated between the poles of a more powerful magnet, the galvanometer needle showed continuous deflection. The experiment was a complete success—the first direct-current dynamo. On the 24th November, 1831, Faraday reported his work in a paper which he read before the Royal Society.

Faraday's experiments formulated the idea of lines of force in the space between those bodies which showed electrical and magnetic properties. As he studied the pattern assumed by iron filings spinkled over a card laid on a magnet or on a wire carrying a current, he gradually developed the concept of a field of force associated with these curved lines. This not only gave Faraday an explanation of the experimental results he had produced, but ultimately proved to be the starting point for electromagnetic theory.

Faraday's discovery, in turn, opened up a new surge of progress: Joseph Henry (who also discovered electromagnetic induction but whose findings were published after those of Faraday) can be credited with many discoveries such as the step-down and step-up transformer; Georg Simon Ohm developed the simple law to explain the behaviour of electric circuits; Karl Friederick Gauss and Wilhelm Eduard Weber pioneered the system of absolute units which greatly helped the practical applications of electricity; and James Clark Maxwell's pioneering work on the theory of electromagnetism, which, in demonstrating the relationship between electric and magnetic forces, established the fact that electrical energy can be propagated by means of electromagnetic waves, thus laying the foundation for radio communication.

There were, of course, many other great scientists associated with the progress of electricity in the 19th century. For example, there was Swan's and Edison's development of the incandescent lamp, Sir William Thomson's (later Lord Kelvin) many inventions and his theory of the submarine cable which he developed 125 years ago, Werner von Siemens' introduction of the shuttle armature which was also introduced in 1856, and Graham Bell's invention of the telephone in 1875.

However, so many electrical discoveries and inventions were made in the latter part of the 19th century that to describe each would be outside the scope of this *IEC Bulletin* report.

1881...

The Electrical Congress and Universal Exposition

By Mr. M. du Couëdic of the French National Committee of the IEC

Among all the anniversaries that we are celebrating this year, a special place should be given to the centenary of an important event—the first international Congress of Electrical Engineers in 1881 which laid down the foundations for the prodigious development of the electrical industry.

This Congress was held in Paris from 15th September to 5th October 1881 in the Palais des Champs-Elysées, as well as the Exposition which formed the "laboratory" of the Congress. Sometimes called the "Palais de l'Industrie", the Palais des Champs-Elysées was a vast metal construction similar to the Crystal Palace in London; on the occasion of the Universal Exposition of 1900, it was replaced by the present Petit Palais and Grand Palais.

An assembly of scientists and engineers

Twenty-eight countries replied to the invitation of the French government and sent delegations, each led by their ambassadors. The list of two hundred and fifty members of the Congress contains a number of illustrious names: Helmholtz, Kirchhoff Siemens, Mach, Gramme, Rowland, Becquerel, Fizeau, Deprez, Planté, Lord Rayleigh, Lenz, Tresca, Nyström, and many others.

The Congress was opened by the French Minister for Postal and Telegraph Services, who presided over its work. One of the Vice-Chairmen was Sir William Thomson, the future Lord Kelvin and first President of the IEC, then 57 years of age.

The Congress was divided into three sections, the first of which dealt with theoretical questions, the second with telegraphy, telephony and railways, while the third dealt with the civil and military applications of electricity. There were seven plenary meetings as well as numerous public lectures.

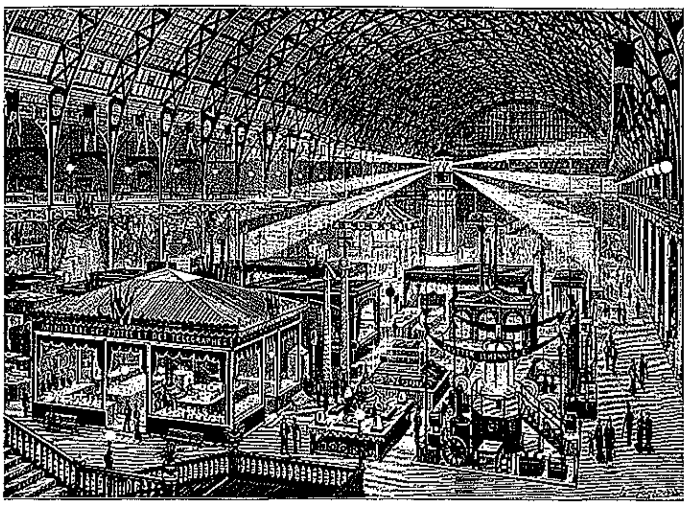
The standardization of electrical units

The standardization of electrical units was without any doubt the most important result of the Congress. Until 1881 complete confusion had reigned in this field; each country had its own units. In Germany, for example, the three principal electrical units were the weber, the daniell and the siemens unit. In England where the British Association for the Advancement of Science had established a rational system, the weber (albeit another weber), the volt and the ohm were used. France used either the English units or other old and badly defined units.

The Congress of 1881 had the great merit of studying this question at international level, and decided to adopt a common system based on the work of the British Association and linked to the metric system.

Terrestrial magnetism, lightning and meteorology

The first section of the Congress completed its work on units of measurement by recommending the setting up of an international



Night view of the main hall of the Electrical Exposition seen from west end

commission entrusted with the definition of international standards, and the continuity of this work. It also made some proposals for a systematic study of terrestrial currents, later to be the subject of a world-wide campaign of simultaneous measurements during the years 1882 and 1883. It recommended the setting up of an international commission for the study of atmospheric electricity and the collection of statistical data on the effectiveness of the various types of lightning conductors in use at the time. Finally, it proposed that a world-wide telecommunications network should be set up for the establishment of weather forecasts.

Telecommunications

The first transatlantic cable had been laid in 1866—fifteen years before the Congress. Bell's telephone had appeared on the scene at the Universal Exposition in Philadelphia in 1876. It was therefore hardly surprising that the study of electric cables was one of the principal preoccupations of the Congress. The second section, to which this matter had been entrusted concerned itself with the effect of thunderstorms on overhead lines, and produced a complete report on optimum designs for posts, wires and insulators, and finally decided that conducting wires would in future be designated by their diameter in millimetres. It noted with approval that in the previous year the international rules for avoiding collisions at sea had incorporated special provisions for the protection of cable-laying ships. Finally, the section emphasized the importance of future developments in electricity for railway operation.

Transmission of energy

In 1881, the transmission of power over a distance was only in its infancy. At the Congress, the French scientist Marcel Deprez demonstrated his theory on the transmission of electrical energy, which he put to practical use the following year in supplying power to a printing works in Grenoble from a generator located fourteen kilometres away. A similar demonstration was made at the Munich Exposition of 1882.

Lighting

Together with the transmission of energy, lighting was one of the important subjects entrusted to the third section of the Congress. Three years earlier, Edison and Swan had independently invented the incandescent electric lamp. The measurement of the intensity of illumination from electrical sources and the comparison of various photometric methods gave rise to lengthy discussions. Finally, the Congress recognized that none of the methods then in use possessed any decisive advantage, and recommended the creation of an International Commission to define a standard of illumination.

The electrical exposition

Electricity had, of course, been given a place at all the previous universal expositions, such as London (1862), Paris (1867 and 1878), Vienna (1875) and Philadelphia (1876), but this was the first time that a universal exposition devoted exclusively to the applications of electricity had been staged. The idea was due to the outstanding personality of Dr. Cornelius Herz (not to be confused with the discoverer of Hertzian waves). This leading industrialist, an American citizen born in France, did much to promote the idea of the Paris exposition in his journal, *La Lumière électrique*.

The idea gained ground and was finally implemented by the French government. Now, to round off this evocation of electricity in the last century, let us for a few moments join the crowd of 750,000 visitors who passed through the Exposition between 10th August and 20th November 1881. On entering the main door of the Palais des Champs-Elysées, we would be confronted with a giant lantern for a coastal lighthouse with rotating lights of various colours. To the west, the pavilion of the Postal and Telegraph Services featured an ingenious apparatus for synchronizing public clocks in the various districts of Paris, as well as an alarm system for the use of the fire brigade. The eastern door remained permanently open for the electric tram running from the Exposition to the Place de la Concorde. The generators supplying more than a thousand electric lamps of different types occupied the whole of the south side. This illumination consumed more power than the total lighting system of the city of Paris in 1881. On the first floor a large number of cabins enabled a visitor to become acquainted with the telephone or to listen to performances from the Opéra and the Théâtre-Français. Further on, two entire rooms were devoted to Edison's inventions. All kinds of devices, the one giving way to something even more wonderful than the other, would confront us. Together they represented a complete picture of the electrical industry of the day.

If we try to sum up today this International Congress, we realise that its consequences were immense. It enabled the results of the work of electrical engineers and physicists throughout the 19th century to be brought together, and provided guidelines for their future work. Whilst it cannot be said that the outline of the future IEC had yet become discernible among the three International Commissions whose creation was deemed necessary for continuing the work of the Congress, it is true to say that it was here that was born the spirit of international standardization; electrical engineers of all countries had learned to work together and had become aware that electricity would transform the entire world.

ELECTRICAL UNITS

The seven resolutions of the 1881 Congress:

1. For electrical measurements, the fundamental units, the centimetre (for length), the gramme (for mass), and the second (for time), are adopted.
2. The ohm and the volt (for practical measures of resistance and electromotive force or potential) are to keep their existing definitions, and 10^9 for the ohm, and 10^8 for the volt.
3. The ohm is to be represented by a column of mercury of a square millimetre section at the temperature of zero centigrade.
4. An International Commission is to be appointed to determine, for practical purposes, by fresh experiments, the length of a column of mercury of a square millimetre section which is to represent the ohm.
5. The current produced by a volt through an ohm is to be called an ampère.
6. A quantity of electricity given by ampere in a second is to be called a coulomb.
7. The capacity defined by the condition that the coulomb charges it to the potential of a volt is to be called a farad.

1904...

The founding resolution

Whilst the 1881 International Electrical Congress was of importance to the electrical world, the result of a later one, held at St. Louis, U.S.A. in 1904, cannot be underestimated.

As part of the Congress, on Tuesday, the 13th September, 1904, a meeting of the Chamber of Government Delegates to the International Electrical Congress met at the Hotel Jefferson. Two committees were set up to examine international electromagnetic units and international standardization. The following day, once again at the Hotel Jefferson, a further meeting of the Chamber of Delegates was held to receive the reports from these committees.

The report of the committee on international electromagnetic units stated that "there are considerable discrepancies between the laws relating to electric units, or their interpretation, in the various countries represented, which, in the opinion of the chamber, require consideration with a view to securing practical uniformity".

The report continued: "Other questions bearing on nomenclature and the determination of units and standards have also been raised, on which, in the opinion of the chamber, it is desirable to have international agreement." The report concluded "that these and similar questions could best be dealt with by an international commission representing the governments concerned."

But it was the report from the second committee, on international standardization, endorsed by a full meeting of the Chamber of Government Delegates that two years later led directly to the founding of the IEC. This recommended that:

"... steps should be taken to secure the cooperation of the technical societies of the world by the appointment of a representative Commission to consider the question of standardization of the Nomenclature and Ratings of Electrical Apparatus and Machinery."

1906...

The Commission is born

It was in London, on the 26th June 1906, that the preliminary meeting of the IEC was held. Thirty-three delegates from 14 countries were present to discuss the proposed Rules for the Commission which "endeavoured to place every country on an absolutely equal footing, to accord each country perfect freedom to arrange the affairs of their respective Local Committees and also to keep the Constitution of the Commission as simple as possible". The IEC's first Sub-Committee was then formed, with one representative from each country as members, to study the proposed Rules and report back to the Commission the following day.

The Sub-Committee met under the Chairmanship of Mr. Alexander Siemens of Great Britain. Subjects prominent in the discussions were:

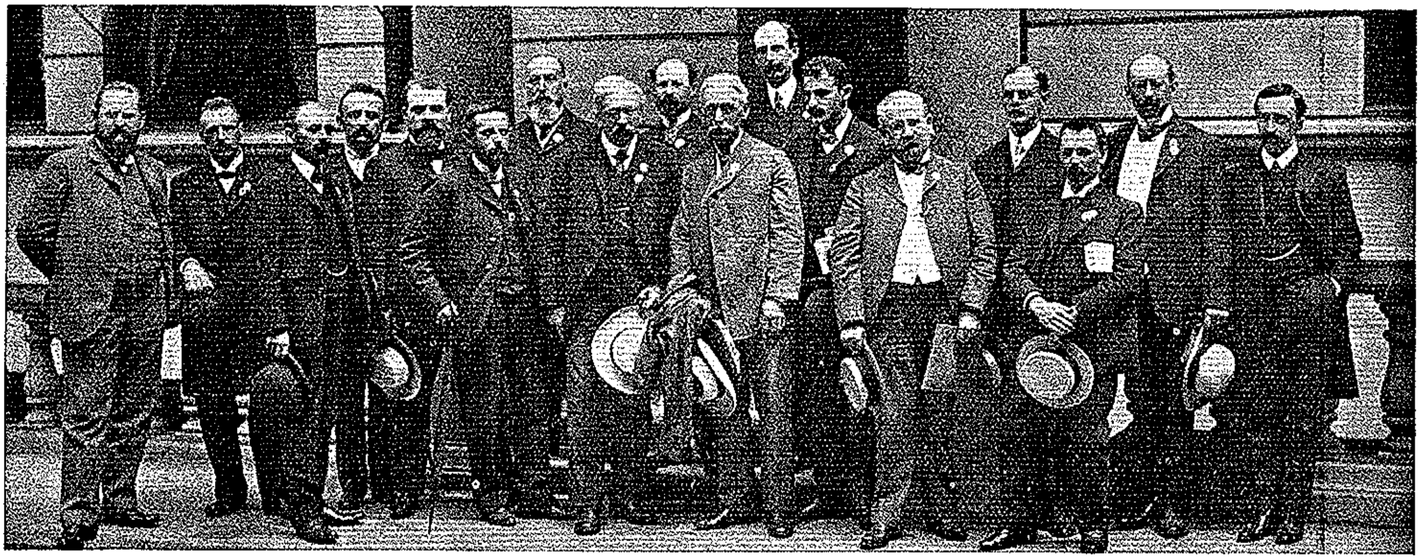
- that manufacturing interests should be represented on the Local Committees;
- matters concerning the appointment of the Local Committee by the government of any country having no Electrotechnical Institution;
- the period during which a Technical Society shall have been in existence before it can appoint a Local Committee;
- the voting power of each country.

Several amendments to the original Rules were suggested and subsequently agreed upon by the Sub-Committee. A redraft, with a corresponding version in French, was then prepared for presentation to the Meeting of the full Commission the following day.

The Sub-Committee proved to be the shortest lived Committee the IEC has ever had. It was disbanded after being in existence for only one day. The redraft, with minor amendments, was adopted on the 27th June 1906, the result of which was the formal constitution of the IEC.

One of the minor amendments concerned the title of the Commission. Originally, it was envisaged that the title should read "International Electrical Commission". But Dr. Crocker of the U.S.A. considered the term "electrical" in the title as "somewhat ambiguous" as it would be applied, for example, to a Commission which had to do with magnetic units. His suggestion that the ambiguity would be avoided if the word "electrotechnical" were substituted was adopted unanimously.

At that first Meeting of the IEC, the first of many eminent scientists and engineers to serve as President was elected—Lord Kelvin. Another leading engineer and industrialist of the period was appointed the First Honorary Secretary of the Commission, in recognition of his work in the founding of the IEC—Col. R. E. B. Crompton.



London, 26th and 27th June 1906: The first meeting of the IEC

C. Dettmar, W. Smitt, E. Feldmann, D. Harsanyi, Boucherot, Farny, L. Gerard, Al. Siemens, P. Janet, Col. Crompton, H. Rosenberg, Mailloux, Crocker, David, Semenza, Le Maistre

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