CHAPTER 4

INSTITUTION OF ELECTRICAL ENGINEERS
FOUNDATION OF SOCIETY OF TELEGRAPH ENGINEERS

When the Society of Telegraph Engineers was formed the interests of the small but growing body of professional electrical engineers were limited mainly to the subject of telecommunication. The eight founder members, five of whom held military rank, met on the 17th May 1871, at 2 Westminster Chambers, Victoria Street, SW. The minutes of the inaugural meeting of the Society include the following extracts:

> "It was duly moved and seconded that Mr. Whitehouse do take the Chair and that Maj. Bolton act as Secretary to the meeting. The Chairman informed the meeting that it was called together to consider the expediency of forming a Society of Telegraph Engineers, having for its object the general advancement of Electrical and Telegraphic Science, and more particularly for facilitating the exchange of information and ideas among its members—and it was resolved that, as in the opinion of this meeting, the formation of such a Society is desirable—the gentlemen present do constitute themselves a preliminary committee to elect Members and to prepare suitable names to fill the offices of President, Vice-Presidents, Members of Council, Secretary, Treasurer and Auditors'.

The Society was launched successfully. The List of original members contained 66 names. The first President was Charles William Siemens, F.R.S., who became President of the Institution of Mechanical Engineers in the following year. He was knighted in 1883.

Nine years after the Society was formed, the title was changed to the Society of Telegraph Engineers and Electricians. This reflected the first change in a developing situation. The second change occurred in 1889 when the present title was assumed, namely the Institution of

Electrical Engineers. It had become apparent that electrical engineering was an omnibus term that could conveniently include all aspects of this particular branch of engineering.

INSTITUTION OF ELECTRICAL ENGINEERS

When the Institution of Electrical Engineers celebrated its Centenary in May 1971 (it had been granted a Royal Charter 50 years previously) it had more than 60 000 members whose interests ranged through such fields as electricity supply, radio and television broadcasting, telecommunication systems and electronics, industrial control and automation, and microelectronics. The Institution had also been actively concerned with national codes for the safety of electrical installations. It had assumed responsibility for the education and training standards for professional electrical engineers. It published a range of periodicals, books and conference publications. *Science Abstracts*, a particularly valuable publication, had been available since 1898 when it was produced under the joint auspices of the Institution and the Physical Society. These activities, of course, continue.

The History of the Institution of Electrical Engineers (1871–1931) by Rollo Appleyard, was published by the Institution in 1939. It provides a valuable source of information for the period concerned. The Centenary number of *Electronics & Power*, the Institution's Journal, for April–May, 1971 (Vol. 116, pp. 135–206) includes a summary of events connected with the Institution covering the first hundred years from its foundation.

Local Centres

The need for the extension of the activities of the Society of Telegraph Engineers in the provinces was raised in 1880 when a proposal for setting up branches was received from a correspondent in Manchester. However, 18 years elapsed before a committee set up by the Council of the Institution to consider changes in the Articles of Association decided that the formation of Local Sections was desirable.[1] One of the subjects referred to the committee by the Council was a possible affiliation of the Northern Society of Electrical Engineers.[2] This

society was founded in 1893 to permit members of the electrical engineering profession in the Manchester area, unable to attend meetings of the Institution in London, to meet and become acquainted with each other. The society intended neither to oppose nor rival the IEE. In fact, many of the engineers who joined the society when it was founded were already members of the Institution.

The Founder President was Dr. John Hopkinson, FRS (1849–1898) who had served as President of the Institution of Electrical Engineers in 1890, and was elected President for a second term in 1896.

The objects of the society were:

> 'to hold meetings for the promotion of Electrical Science and its commercial and other applications and for social intercourse between the members'.[3]

Some of the members came from Liverpool but only one of the society's ordinary meetings was held in the city, at the University College, in March 1895. This was the 7th meeting and the only one to be held outside Manchester. F. G. Bailey, M.A., a member of the society read a paper entitled 'The Scientific Foundations of Electrical Engineering'.

During the society's existence a cordial but informal relationship existed between the society and the IEE, so that, when the question of amalgamation arose, the negotiations were successfully concluded. The formal act of amalgamation took place on the 8th March 1900, and the Northern Society of Electrical Engineers became the Manchester District Local Section of the Institution of Electrical Engineers.[4] The Council of the society became the first Committee of the Local Section. The members of the society at this time numbered 166, of whom only 75 were nonmembers of the IEE. This amalgamation heralded the regional development of the future.

The first meeting of the Manchester Local Section was held on the 13th November 1900, in Owens College. During the first ten years of the Section's existence, only one meeting was held outside Manchester, when a joint meeting was held in Liverpool with the Liverpool Engineering Society. A paper was read by L. J. Hunt entitled 'Notes on the design of electrical machinery'. In 1904, the formation of the Manchester Students' Section was approved by the Council of the Institution. Joint meetings with the Liverpool Engineering Society

were held in 1911, and during the 1913–14 and 1914–15 sessions at Liverpool University. Similar joint meetings arranged in the 1915–16 and 1916–17 sessions took place at the Royal Institution, Colquitt Street.

Territorial Centres

When the President of the Institution (C. H. Wordingham, CBE) visited Manchester in December 1918 to deliver his 'Address to the territorial centres', he said:

> 'One of the most conspicuous things we did last session was to improve the status and extend the responsibilities of what were then called Local Sections. We have renamed them "Territorial Centres" and we now call them by the names of different parts of the country instead of by the name of an individual town or city in order to emphasise that they cover a whole area and are not simply local to one town'.

The President then went on to say that:

> 'Very much more responsibility is now given to the Committees of these Centres, and they are taken fully into the confidence of the Council. In the past the Chairman alone was conversant with what went on in the Council; he was bound down by promise of secrecy not to tell his Committee what passed at the Council Meetings and in consequence was often placed in a most invidious position. That condition has now been done away with and the Chairman is at liberty to communicate the whole of the Minutes of the Council to all members of his Committe'.[5]

The name Local Section was changed to Territorial Centre in 1918, and the name of the Manchester Local Section was altered to the North-Western Centre of the Institution.

After the 1914–18 War the North-Western Centre Committee gave consideration to the formation of one or more Sub-Centres. It was suggested that both Preston and Liverpool would be appropriate areas for such development.

THE LIVERPOOL SUB-CENTRE

The Liverpool Sub-Centre of the North-Western Centre was

formed on the 21st November 1919, when the inaugural meeting was held at the University of Liverpool. The area included 'those parts of Lancashire and Cheshire to the west of a line joining Southport, Wigan and Warrington, but including those towns, and from Warrington to a point on the Cheshire County boundary south of Chester and including that city'.[6]

J. A. Robertson, Chairman of the North-Western Centre, acted as chairman. He was supported by Prof. E. W. Marchant, H. Dickenson, Dr. W. Cramp, and B. Welbourn. A. G. Ellis and A. L. Green, Hynorary Secretary and Honorary Assistant Secretary respectively, of the North-Western Centre, were also in attendance. The meeting attracted 72 members and visitors.

Mr. Robertson suggested forming a Sub-Centre in Liverpool, as had recently been done at Preston with considerable success. Following a discussion, G. H. Nisbett proposed, and H. Dickenson seconded, the proposition 'that this meeting resolves to form a local Sub-Centre of the Institution of Electrical Engineers in Liverpool', which was carried unanimously.[7] A provisional Committee was then elected to hold office until the end of the session. Prof. E. W. Marchant was appointed Chairman; H. Dickenson, Vice-Chairman, and O. C. Waygood agreed to act as Honorary Secretary. Col. Bates and Messrs. Clothier, Hollingworth, Lang, Nesbitt and Welbourn *(Members)*, and Messrs. Bailes, Hamilton, Harrison, Hawkins, Macdonald and Spencer *(Associate Members)* were also elected, making a total of 15 to serve on the Committee. It was agreed that the first meeting should take place on the 19th January 1920.

At a meeting in December 1919, the formation of a Students' Section was considered. Dr. Marchant took the Chair, and was supported by Mr. Waygood the Honorary Secretary. The meeting was attended by 49 members and visitors. In his address Dr. Marchant stated the aims and objects of the Institution, and strongly supported the proposal that a Students' Section in the Liverpool area would be advantageous. He assured the students present that it was not intended that the proposed section should interfere in any way with the activities of the Liverpool University Engineering Society. It was then proposed 'that a Student Section be formed in Connection with the Liverpool Sub-Centre of the Institution of Electrical Engineers', and carried unanimously. A committee was then formed with Mr. O'Neill

as Chairman, N. Yeadon as Vice-Chairman, and F. F. Best as Honorary Secretary, with eight others.

To consolidate the setting-up of the Sub-Centre a second Committee meeting was arranged in December with Dr. Marchant in the Chair. The N.W. committee granted £50 for expenses. Following a discussion, it was resolved that the area of the Sub-Centre should include Southport through Warrington to Wigan, to Crewe to Wrexham, to Mostyn, back to Southport and North Wales generally.

The Committee met again in January 1920, and the desirability of publicising meetings was agreed. Mr. Budge of the *Journal of Commerce* undertook to publish reports of meetings and confirmed that he should be paid a fee of one guinea for attending, plus 7d per folio of 72 words.

Prof. Marchant took the chair at the Ordinary General Meeting held on the 19th January 1920, at the university. Some 200 members and visitors were present. The Vice-Chancellor of the university, Col. John G. Adami, addressed the meeting and welcomed the members of the Sub-Centre to the University. Roger T. Smith and C. H. Wordingham were present and spoke on behalf of the Council of the Institution. Prof. Marchant then delivered the Chairman's Address.[8] He referred to the address of the Institution's first President, C. W. Siemens, and quoted his opening sentence:

> 'Our future prosperity will be influenced in a great measure by the direction in which we shall start our pilgrimage. Let us hope, therefore, that our joint efforts may lead us in the direction of true scientific and practical advancement'.

Prof. Marchant pointed out that the Liverpool Sub-Centre started in 1920 with more than twice as many members as the whole Institution at its inception. He felt that each Sub-Centre 'should have a character of its own, controlled very largely by local conditions'. He said that Liverpool was an unrivalled centre for the study of problems found in electric power on ships. The district had a very close connection with the cable industry and he believed that:

> 'the new problems arising in connection with the distribution of electric power from large super-stations will give the members of our Sub-Centre many fruitful evenings of discussion on the design and construction of overhead and cable lines'. He said that Liverpool contained 'one of the largest factories in the country for the manufacture of telegraph and telephone apparatus.' He went on to say

'of all the branches of this problem (communication), the one which Liverpool people must fully appreciate is wireless telegraphy. The shipping industry is by far the biggest in the district, and anything which tends to make the journey of the steamship safer must be of interest to the shipowner'.

Prof. Marchant also considered that much greater attention should be given to electrical engineering in chemical works, for example, problems connected with electrochemistry. He hoped that contributions would be forthcoming from engineers connected with the chemical manufacturer in the neighbourhood of Liverpool. In conclusion he discussed the future of the electrical engineering graduate. He did not doubt that the large numbers being trained would find occupations in electrical engineering. He felt that the outlook for the technical graduate was most encouraging. Following the address demonstrations in wireless telegraphy and telephony were given in the electrical laboratory.

At a meeting held in March, Lieut.-Col. H. E. O'Brien, D.S.O., *(AM)*, read his paper on 'The Application of the Electrical Locomotive to Main-line Traction on Railways'.[9] The author reminded his audience that electric locomotives were first used on a large scale in 1890 on the City and South London Railway. They were introduced on the Baltimore and Ohio Railroad in 1896. In 1900 the Central London Railway was opened for public traffic, and the Metropolitan Railway was electrified in 1904. At the time, the speaker said, there were some 1200 electric locomotives in service on the railways of the world.

The business at Committee meetings now tended to become more formal. Applications for election and transfer of local members were received from both headquarters and the North-Western Centre to the Committee for their consideration. The Committee decided to continue to meet at the university although the Director of Education had advised the Hon. Secretary that the use of rooms at the Central Technical School were available. Prof. Marchant assured the members that the Committee would be very welcome at the Laboratories of Applied Science.

The 5th Ordinary General Meeting was held in April 1920, when Dr. C. V. Drysdale, O.B.E., D.Sc., *(M)*, gave the 11th Kelvin Lecture entitled 'Modern marine problems in war and peace'. The Kelvin Lecture was instituted in 1908, to be delivered annually before the

Institution in London, by an eminent scientist selected by the Council. The Lecture commemorates, but is not necessarily connected with, the life and work of Lord Kelvin, President of the Institution in 1874. The first lecture of the series was given by Prof. Silvanus Thompson, F.R.S., who took as his subject 'The life and work of Lord Kelvin'.

The lecture given by Dr. Drysdale was the first to follow the Council's decision that the time had come for the Kelvin Lecture 'to embrace other fields than those of Lord Kelvin's personal activities'.[10] The lecturer surveyed the work carried out in the Admiralty's various experimental stations both during and after the First World War. He discussed a number of discoveries made during the war relating to the detection of ships, submarines and icebergs; and methods of determining the position of ships, and land and sea stations, under conditions of invisibility. The lecture was illustrated by lantern slides, diagrams and apparatus. It was attended by 160 members and visitors.

At the 7th Committee Meeting held on the 19th April, 1920, with Dr. Marchant in the chair, it was resolved that the Committee of the North-Western Centre should be asked to recommend that the proceedings of the Sub-Centre should be published in the Institution's *Journal*, and various papers and discussions were mentioned as being suitable for publication. It was also agreed that an account should be opened with the Bank of Liverpool and Martin's Ltd.

The Committee met again on the 12th July when Prof. Marchant reported that he had made arrangements for Committee Meetings next session to be held at the University Club. This arrangement continued when the Centre was formed up to the Second World War. A dinner would be provided at the close of Committee Meetings at a charge of five-shillings per head.

The 9th Committee Meeting was held on the 11th October 1920, with Prof. Marchant in the chair. At the request of the Honorary Secretary, J. H. C. Brooking attended to present details of his scheme referring to the utilitarian aspect of the Institution in regard to its Provincial Members. He proposed the setting up of Branch offices or clubs in provincial towns. These would provide lending libraries and reading rooms for technical journals and other material. Following a discussion Mr. Brooking was requested to revise his scheme in more detail and the Committee undertook to forward his proposals to the

North-Western Centre Committee for consideration. However, there do not appear to be any subsequent developments.

The University was the venue for the 6th Ordinary General Meeting held in November, when Mr. Dickenson delivered his Chairman's Address entitled 'Electric supply'.[11] He had been city electrical engineer in Liverpool since 1912 and two years later, the City Council would also appoint him city lighting engineer. He was responsible for installing many sub-stations, including rotary converter automatic sub-stations, which had not previously been employed in this country.

In his address Mr. Dickenson dealt with electric supply, distribution and costs. He mentioned the provisions of the Electricity (Supply) Act 1919, and stressed the potential demand for electricity. It was gratifying to know that cable makers were prepared to supply cables for working at 66 000 V, compared with those being made at the time for working pressures of 33 000 and 55 000 V. Mr. Dickinson reminded his audience that the cost of coal had increased from three to four times what it was before the war, and, at the same time, it had deteriorated in quality. In view of high costs, the efficiency of generating plant had become a matter of immense importance.

A paper entitled 'Some economic aspects of extra-high-tension Distribution by underground cable' by R. O. Kapp, B.Sc., *(AM)*, was read at the 8th Ordinary General Meeting in December.[12] The author pointed out that:

> 'with the heavy cost of feeders on modern power schemes, due to the centralization of the generation of electricity in very large power stations, a saving in the capital outlay on the EHT distribution system will assume an economic importance comparable with that of reductions in coal consumption'.

Mr. Kapp discussed various means for keeping the cost of the distribution system as low as possible without sacrificing safety. He stressed that 'the primary object of generating electricity in super power houses is the conservation of our coal supplies'. He considered the choice of the most economical position for the power house and transformer houses; the choice of the most economical voltage, various types of cable layout; means of ensuring that all radial feeders would be fully loaded; making the fullest use of the current carrying capacity of cable, and the use of tariffs for obtaining the best use of the distribution system.

At the meeting held under Mr. Dickinson's chairmanship on the 7th February 1921. E. B. Wedmore, the Association's Director of Research, introduced the report on 'Research on the Heating of Buried Cables', which had been received from the British Electrical and Allied Industries Research Association.[13] The report had been prepared following an investigation 'to provide definite values of current-carrying capacity for cables laid underground in the conditions prevailing in practice in this country'. Liverpool Corporation was one of the bodies which provided some of the more expensive cables tested. Section III of the report provided details of work undertaken at Liverpool University on vulcanised bitumen cables laid solid in stoneware troughing.

A paper that attracted the attendance of 140 members and visitors was entitled 'The long distance telephone system of the United Kingdom', by Sir William Noble, and read in his absence by T. E. Herbert, on the 11th April 1921.[14] The paper described the development of the trunk telephone since 1905. The new trunk line system was almost entirely underground. Details were given of the balanced cable laid between London and Liverpool in 1914. The author stated that the telephone repeater became a practical proposition when the 3-electrode thermionic amplifier was evolved; and the general introduction of telephone repeaters into long distance lines had led to what was almost 'a revolution in long-distance communication schemes'. The methods of duplexing the thermionic amplifier in order to obtain both-way working was also described. The paper concluded with a reference to the introduction of high-frequency carrier-wave telephony and its application to long-distance communication.

On the 15th August 1921, a Royal Charter of Incorporation was granted to the Institution of Electrical Engineers, which gave the Council great pleasure. One result of the new Bye-laws approved by the Privy Council for the Chartered Institution was the change of designation from 'Territorial Centre' to 'Local Centre'.

1921–22

G. H. Nisbett (see Fig. 28), as the newly elected Chairman of the Sub-Centre for 1921–22, gave the Chairman's Address on the 7th November, 1921.[15] Since 1894 he had been Chief Engineer of the

British Insulated Cables Co. (known as the British Insulated Wire Company at the time of his appointment). In 1924 he was appointed Director and Engineer. Four years later he became Managing Director. Formerly, as Chief Electrical Engineer to the City of London Electric Lighting Co. he designed and laid down the first low-voltage a.c. distribution system in the country. He was responsible also for introducing lead-covered cables for underground distribution on a large scale. During the thirty-four years he spent with British Insulated Cable he was responsible for many inventions associated with the manufacture of electric cables. Mr. Nisbett died in 1940 aged 73.

In his Chairman's Address he drew attention to the need 'for the display of more enterprise in seeking the extension of electricity supply and particularly new lighting consumers'. He referred to the unprecedented slump in trade which had begun to affect electrical interests. He called attention to the need for the standardisation of fittings, particularly wall plugs. He suggested that, if the British Engineering Standards Association (now the British Standards Institution) could not be persuaded to take up the matter, a committee of the Incorporated Municipal Electrical Association should deal with the question in its own interests. Another matter that required attention was 'the need for greater care in the earthing of appliances such as kettles, irons and cooking appliances'. It appeared to be 'nobody's job to see that the householder is protected against dangerous shock'.

The President of the Institution, J. S. Highfield was present at a meeting held in December 1921, which was attended by 114 members and visitors. Incidentally, Mr. Highfield was a former Chief Engineer to the St. Helens Local Authority. After he had given an address, Professor S. P. Smith, D.Sc., *(M)*, delivered a lecture on 'Single- and 3-phase commutator motors with shunt and series characteristics'.[16] The lecturer discussed the requirements for a.c. motors, namely a high power factor; large starting torque, and economical speed regulation. The subject was topical because of the rapid growth of a.c. networks leading to increasing demands for a.c. motors. Following the discussion, the meeting adjourned to the Laboratories to witness experiments on a machine having the characteristics dealt with in the lecture.

At the 22nd Committee Meeting held on the 16th January 1922, the Honorary Secretary reported that the North-Western Centre Committee had made application to the Council for 'that portion of North Wales at present unattached to any other Centre to be included in the North-Western Area, and in the event of the allocation of this Area to the North-Western Area they propose attaching it to the Liverpool Sub-Centre'. The proposal was accepted by the Council.

In February 1922, the Institution of Electrical Engineers held a series of Commemorative Meetings to celebrate the Jubilee of the Founding of the Society of Telegraph Engineers in 1872. On the 22nd February, Sir Oliver Lodge presented a paper which included the following extract:

> 'I was scientific adviser to the Electrical Power Storage Co. for a time, and that company ran an early electric tramcar. It had storage batteries under the seats. I remember devising a scheme for putting the motors in series for starting and in parallel for running. We went out about six in the morning on a trial trip. The first day was a failure, because the car ran out of the yard too vigorously and refused to take the bend into the road. It did not stop but went straight across the pavement towards a shop window opposite. the test had to be put off for another day. Next day it took the bend all right, and when travelling placidly along the road we met a milk-cart in the early morning. It was very interesting to see the intelligence of the animal in the shafts of the milk-cart. The tramcar looked like any other tramcar, and there were lots of horse tramcars in the neighbourhood. But this one had no visible means of propulsion, and the horse noticed it, looked again to see what was pulling it, and then began backing away; it knew the car ought not to be able to go like that without a horse'.[18]

G. H. Nisbett was in the Chair at the Ordinary General Meeting held on the 20th March 1922, when J. B. Palmer read a paper on 'The inter-connection of a.c. power stations', by L. J. Romero and himself.[19] The speaker discussed 'the special factors to be considered in designing an interconnecting link between two a.c. stations, with particular reference to power factor and power factor control'.

Alexander Graham Bell died on the 2nd August 1922, aged 75, in Canada. He invented the telephone in 1875, but it was not until the following year that the first complete sentence was spoken and heard between persons in two rooms in a building at Boston, U.S.A.,

1922–23

The new session commenced on the 6th November 1922, when Burkewood Welbourn delivered his Chairman's Address.[20] He described the immense progress which had taken place during the past fifteen years in Canada and the United States. An extensive use was made of the telephone for both short and long distance work. Out of some 14·3 million telephone stations in the United States about 850 000 were on the Strowger system as made in Liverpool. One noticeable feature in telephone work was the free way in which lead-sheathed cables were used overhead. Broadcasting was in a chaotic state owing to lack of control in the initial stages of development. There were some 500 broadcasting stations in the United States in 1922. Mr. Welbourn was very impressed with the development of electricity supply. Transmission pressures were operated at 165 000 volts a.c., and a 240-mile line had been built to operate at 220 000 volts. The suspension type insulator which some years previously had been exceedingly unreliable, was now used with confidence.

In November 1922, A. P. M. Fleming gave his lecture on 'Broadcasting', which was illustrated by lantern slides, experiments and demonstrations in radio reception. 'A (musical) programme was transmitted from the Broadcasting Station in Manchester, Metropolitan Vickers Co., and easily picked up in the lecture room'.[21]

Sir Arthur Fleming, C.B.E., D.Eng., Hon.M.I.E.E., (he was knighted in 1945) became President of the Institution of Electrical Engineers in 1938-39. In 1941, he was awarded the Faraday Medal of the Institution. He was responsible for research and education at the Metropolitan Vickers Electric Co. Manchester, for a long period. He died in 1960.

The prospect of the Liverpool Sub-Centre becoming a Local Centre was discussed at several meetings. In November, 1922, W. Lang proposed, and A. E. Malpas seconded the resolution authorising the Chairman to approach the Council, and to enlist the support of the North-Western Centre. Following a meeting held in January, 1923, a petition was drawn up for presentation to the Council, supported by the North-Western Centre, and proposing the title 'Liverpool Centre'.

CHAPTER 5

INAUGURATION AND EARLY YEARS OF MERSEY & NORTH WALES (LIVERPOOL) CENTRE 1923–1933

1923–24

The 1st Ordinary General Meeting of the Mersey & North Wales (Liverpool) Centre of the Institution of Electrical Engineers was held on the 19th February 1923, at Liverpool University. In the presence of the Lord Mayor of Liverpool and 140 members and visitors, the Chairman, B. Welbourn, made a formal announcement 'that the petition for the formation of a Centre with Headquarters in Liverpool had been granted by the Council, and that the name of the new Centre is 'Mersey & North Wales (Liverpool) Centre'.

The Chairman also informed those present that at a meeting of Corporate and Associate Members, the following had been elected to form the Committee for the Centre:

Chairman: B. Welbourn
Vice-Chairmen: E. M. Hollingsworth and H. H. Harrison

Committee:
L. Breach, T. D. Clothier, A. J. Eames, J. Hamilton, B. T. Hawkins, W. Lang, A. E. Malpas, J. A. Morton, E. Moxon, P. Priestly, P. J. Robinson, F. J. Teago, Dr. E. W. Marchant, H. Dickenson, and G. H. Nisbett.

Honorary Secretary: O. C. Waygood.

After the Chairman had welcomed the Lord Mayor to the meeting, the latter gave a short address. The main business was a paper by P. J. Robinson, entitled 'Maintenance of voltage on a d.c. distribution

system by means of a fully automatic substation'.[1] The author described:

> 'the considered methods of meeting a particular case of voltage-drop in a large direct-current lighting network and for bringing into use the maximum amount of copper with a minimum of cost'.

Liverpool led the way in the application of automatic control. The Electric Supply Department decided that all conditions existing in the city should be met by this method. This meant that, apart from the periodical inspection of plant, operating labour could be eliminated.

The 1st Committee Meeting of the new Centre took place on the 19th March, 1923, at the University Club, Liverpool. The Chairman was pleased to report the receipt of a letter from Frank Gill, O.B.E., the President of the Institution, congratulating the Centre on being raised from the position of a Sub-Centre. Members agreed that the Committee should consist of one Chairman, two Vice-Chairmen, 12 ordinary members of committee, and an Honorary Secretary and Treasurer. Nine Members living in the Wigan area were given the choice of registering as members either of the North-Western Centre, or the Mersey & North Wales (Liverpool) Centre. From the replies received, five decided for Manchester and one for Liverpool.

The Honorary Secretary reported on the financial position and advised the Committee that the grant from Headquarters would be made up as follows:

	£
Proportion of grant as Sub-Centre for the first-half of the session	78
Proportion of grant as Centre for the second half of the session	124

These two meetings, one an Ordinary General Meeting, the other a Committee Meeting, inaugurated a Centre, now known as the Mersey & North Wales Centre of the Institution of Electrical Engineers, which has every reason to be proud of celebrating its Golden Jubilee. When the Centre was formed the Institution's membership stood at 10 275, and in 1972 exceeded 64 000. The first 50 years of the Centre's existence have been remarkable for the developments that have taken place in electrical engineering in its broadest sense. They include radio broadcasting and the establishment of television; the construction of atomic power stations; the planning and implementation of the

Grid system; the emergence and growth of electronic equipment, transistors and integrated circuits, as well as many inventions of plant, equipment and apparatus too numerous to mention.

Behind these developments are the ideas and the dedication of many professional electrical engineers. Each member of a Local Centre through his knowledge and skill makes his individual contribution, and the Institution meetings provide a forum for the discussion of new ideas connected with the growth and efficiency of the industry.

It is interesting to recall that the Faraday Medal was established during Mr. Gill's Presidency, to commemorate the 50th Anniversary of the 1st Ordinary Meeting of the Society of Telegraph Engineers. One recipient of the medal was Sir Oliver Lodge, D.Sc., F.R.S., Hon.M.I.E.E., to whom it was awarded in 1932.

Mr. Burkewood Welbourn (Fig. 29), the first Centre Chairman, was a man of considerable ability, whose influence greatly stimulated the development of electrical engineering during its formative years. He studied electrical engineering at King's College, London, where he graduated. Following appointments at Thames Ditton and St. Helens he joined the British Insulated Wire Co. (now the BICC) at Prescot, where he was responsible for executing contracts, and, as a result, travelled extensively overseas. In 1927, he assumed the post of Chief Engineer. Mr. Welbourn acted as Chairman of the Manchester Centre in 1916. He served as a Member of Council of the Institution and became a Vice-President. He died in 1961, aged 85.[2]

The 4th Ordinary General Meeting took place in November 1923, when E. M. Hollingsworth delivered his Chairman's Address. He did not feel that the 1919 Electricity (Supply) Act had brought about the improved conditions anticipated, and the optimistic prophecy of a universal cheap electricity supply from 'superstations' had not been fulfilled. However, he agreed that there had been many advances in power station practice. He mentioned the most notable advances as the application of higher steam pressures and temperatures, the improved treatment and heating of feed water, the increased speed of turbogenerators for a given output, and the stage reheating of steam. The speaker remarked that:

> 'turbogenerator steam consumptions have been reduced to 10 lb per kWH, including the auxiliaries, and an efficiency ration of 77 per cent, including the generator, can be obtained'.

He felt that the improvements contemplated would lead to an increased efficiency ratio and foresaw the prospect of producing 1 kWh for 1¼ lb of inferior coal.

At the time he was elected Centre Chairman, Mr. Hollingsworth held the position of Chief Electrical Engineer to the United Alkali Co. at Widnes. He continued with Imperial Chemical Industries which was formed following the amalgamation of his company with Brunner, Mond & Co., Nobel Industries, and the British Dyestuffs Corporation in 1926. He retired in 1934 when he acted as a consultant until he died in 1937. The writer of the obituary in the *Journal* wrote:

> 'Hollingsworth had a very strongly developed artistic side to his mind. He was a very fair artist, and made beautiful water colour drawings, in later years he took to oils with reasonable success. He had read well and wisely, and talked most interestingly on many subjects. He was a man with the most delightful disposition, was absolutely firm in his convictions, and possessed a most excellent sense of humour, which illuminated his conversation. He was a vivid raconteur and would relate, often in perfect Lancashire dialect, many homely stories about the people he met and liked. A most courteous, kind, and happy man'.

The 6th Ordinary General Meeting held on the 10th December 1923, was attended by 101 members and visitors, including the President (J. A. Brodie) and members of the Liverpool Engineering Society, at which D. Brownlie, B.Sc., read a paper entitled 'Pulverized Fuel and Efficient Steam generating'.[4] The author gave detailed consideration to the latest developments in the use of pulverized coal for steam generation, and compared it with mechanical stoking. He was of the opinion 'that the advantages in the aggregate of pulverized fuel are so great that they constitute almost a revolution in steam-boiler practice'. The use of pulverized fuel in 1923 as a percentage of the total coal used in power stations was less than 0·3 per cent, compared with some 86% in 1971–72.

On the 17th March, a Sub-Committee appointed by the Centre Committee reported they had made arrangements for an exhibition of appliances which would demonstrate the possibilities of cooking, heating and lighting by electricity. A lecture and demonstrations would be included. The Exhibition would be open to members' friends, both ladies and gentlemen. In the evening, Lt. Col. H. E. O'Brien, D.S.O.,

(M), read his paper on 'The Future of main-line electrification on British Railways'.[5] The author favoured extensive mainline electrification in this country. He considered that the total cost of locomotive operation was substantially less for electricity than for steam power. He concluded that, although it was possible to base the argument on general statistics, the problem merited a closer and more immediate investigation than had been given previously.

Many years were to pass before the steam locomotive was eventually superseded by other forms of locomotive. The diesel locomotive continues to be used extensively on non-electrified lines.

On the 25th May 1924, the Council of the Institution dispatched a letter to all Members and Associate Members informing them that under Byelaw No. 9, every Member and Associate member was entitled to describe himself as a 'Chartered Electrical Engineer'.

1924–25

In November 1924, Mr. H. H. Harrison delivered the Chairman's Address, entitled 'The art of communication engineering'.[6] He considered developments in the fields of telegraphy, telephony and signalling methods. He referred to the tendency over the past ten years of the replacement (as far as possible) of the human element by the machine. He quoted as examples the adoption of printing-telegraphs, and the gradual overlapping in technique of landline, cable and radio telegraphy, and of landline and radio telephony, due to methods being borrowed from one another, e.g., the interconnection of landline and radio telephone channels. The author said that considerable progress had been made in the capacity of the submarine cable, two such cables having been laid in 1924. Both had a speed of transmission far in excess of any previous cable. The first had been laid by the Commercial Cable Co. between the UK and New York, which gave a total speed of 1200 letters per minute (i.e. 600 in each direction), which was about double the previous number. The second, laid between New York and the Azores by the Western Union Co., had a speed of 1700 letters per minute in one direction, nearly six times that ordinarily obtained.

Radio telegraphy was also progressing. The author was sure that the

'beam' system recently announced by Dr. Marconi was full of possibilities. Another extraordinary development was the replacement of manually operated telephone exchanges by machine-switching methods. It was no secret that London was being converted from manual to machine operation. Tokio was about to undergo conversion, and Buenos Aires had been in course of conversion for some years.

At an Ordinary Meeting of the Institution held in London on the 6th November 1924, Sir Oliver Lodge, D.Sc., F.R.S., was elected an Honorary Member. He became a Member in 1889, during his professorship in Liverpool, and was Chairman of the Birmingham Local Section in 1901–02, and Vice-President of the Institution during the period 1902–04.

H. H. Harrison was in the Chair at the 14th Committee Meeting held on the 17th November, 1924, when it was agreed that a sum of £15 should be paid out of the local grant to the University of Liverpool as a small acknowledgment for many facilities granted at the Laboratories of Applied Science.

A paper entitled 'An electric harmonic analyser' by J. D. Cockcroft, R. T. Coe, J. A. Tyacke, and Prof. Miles Walker, was presented to the 12th Ordinary General Meeting held on the 17th November 1924.[7] The first named, who became Sir John Cockcroft, O.M., K.C.B., C.B.E., F.R.S., was a pioneer of nuclear research. He was awarded the Nobel Prize for Physics, jointly with E. T. S. Walton, in 1951. He commenced as an apprentice with Metropolitan Vickers and read electrical engineering at Manchester University under Prof. Miles Walker before going up to Cambridge. The final stage of a varied and distinguished career was reached when he became the first Master of Churchill College, Cambridge.

Prof. Miles Walker read the paper mentioned above which was concerned with the experimental harmonic analysis of electromotive force and current waveforms. A modification of the dynamometer method was described which allowed a much higher degree of accuracy to be obtained, and in which the properties of an oscillatory circuit were used to obtain sinusoidal current waves of suitable frequency.

The next meeting was held on the 15th December, when Mr. G. Rogers read his paper on 'Automatic and semiautomatic mercury-vapour substations'.[8] The author dealt briefly with the principal features of the mercury-vapour rectifier, and described some new

applications of the use of automatic and semiautomatic mercury-vapour rectifier substations, designed for developing an efficient and economical d.c. supply to remote areas.

The third of a series of popular lectures sponsored by the Centre Committee was entitled 'The nature of electricity'. It was given by Sir Oliver Lodge, during his retirement, on the 19th January 1925, in the Arts Theatre of the University of Liverpool. It attracted an attendance of 800 people, who provided an appreciative audience.

The working of the Students' Section was discussed at the 19th Committee Meeting held in April 1925, with A. E. Malpas in the chair. The Chairman stated that, in his opinion, something should be done to arouse more interest and enthusiasm among the students. The attendance at recent meetings had been disappointing. Then followed an Ordinary General Meeting when Mr. Perry read Maj. F. L. David's paper on 'Electrcity in mines'.[9] The author dealt with the general problem of power production at mines; methods of applying power-consuming units at mines with particular reference to the utilization of synchronous motors, and Ward-Leonard control for electric winders, and the progressive conversion of several mines from steam to electric drive.

1925–26

A. E. Malpas presented the Chairman's Address at an Ordinary General Meeting arranged in November 1925.[10] His theme was electricity as applied to the electrochemical and electrometallurgical industries. He described a number of manufacturing processes, e.g., the manufacture of calcium carbide and its derivatives; the extraction of metals such as sodium, aluminium and manganese, and exothermic reactions such as were involved in the manufacture of calcium cyanamide.

Mr. Malpas was on the staff of the Ammonia Soda Works, Cheshire, and spent two periods with the United Alkali Co. During the second period he was appointed Chief Engineer, a position that he retained until his retirement in 1925. He died in 1930 aged 60.

'The engineer: his due and his duty in life' was the title of a paper read by Thomas Carter, *(M)*, at a meeting held on the 16th November,

1925.[11] He discussed the rights and duties of life, the rise of modern engineering, the finding of engineers and their training, problems and principles, and engineers and public life. In the discussion Prof. E. W. Marchant commented:

> 'If an engineer sets out in life with the idea of making his fortune I do not think he will give his best service to the world, but if he recognises that all he does is of service to the community, and that his work is of the greatest value when it does the greatest service, he will become a much more useful member of society'.[12]

An Ordinary General Meeting was held on the 15th February 1926, when Dr. P. Dunsheath, O.B.E., M.A., B.Sc., presented a paper on 'Dielectric problems in high-voltage cables'.[13] He was President of the Institution during the 1945–46 Session. His publications include *A history of electrical engineering*, published in 1962. Dr. Dunsheath dealt with several important problems associated with the design, manufacture and operation of high-voltage impregnated-paper cables. They included the phenomenon of dielectric absorption (both theoretical and experimental); fundamentals of a.c. losses; the 'V' curve for loss and power factor; the connection between a.c. and d.c. losses; the rise of power factor with voltage; the nature of cable breakdown, and the assessment of cable quality.

A paper of particular interest in view of later developments in the domestic use of electricity was one entitled 'An All-electric house' by Prof. S. Parker Smith, D.Sc., read at the meeting held on the 19th April 1926, when the domestic load was very low.[14] The author provided detailed information on the domestic application of electricity adopted in a 10-roomed house designed and built in Glasgow for all-electric working. It included details of the distribution board, wiring, bells, lighting, clothes-washing and drying, cooking, the provision of hot water, heating and ventilating, and the relevant running costs. The total cost for the 16 584 units used in one year's working was £43-8s-0d. According to the author, there was much adverse criticism from electrical engineers with whom the scheme had been discussed. For example, a coal fire for the sitting room was almost universally advocated. Another objection was the difficulty of disposing of refuse. mainly garbage, in the house, and this appeared to be the main argument for retaining a coal fire. On the other hand, the layman, and particularly the lay woman, proved to be easier converts 'especially where the domestic-servant problem was acute or where young children had to be considered'.

The Institution celebrated the Jubilee of the Telephone on the 24th June 1926, which was the nearest convenient date to the anniversary of its submission to the International Jury by its inventor, Alexander Graham Bell, at the Centennial exhibition at Philadelphia, USA, on the 25th June 1876. One of the highlights of the occasion was a lecture by Sir Oliver Lodge on 'The history and development of the telephone'.[15]

In the 'Report of the Council for 1925–1926' it recorded that the Wireless Section Committee should get in touch with Local Centre Committees, to ascertain the possibility of starting Local Wireless Sections; stimulating efforts to produce local wireless papers, suggesting the reading of suitable papers, or the giving of lectures at local centres. This suggestion was made at a time when radio broadcasting was becoming increasingly popular.

1926–27

The Chairman for 1926–27 was P. J. Robinson and his Address entitled 'Some problems that have arisen in the electric supply for the City of Liverpool', was given to the Centre in October, 1926.[16] He dealt mainly with the work upon which he was principally engaged, and provided a detailed account of the extensions that had recently been provided at the City of Liverpool's main power station. He pointed out that Liverpool's increase in supply had been abnormal, owing partly to the steady increase in the city's districts, and also as a result of the taking over of the Bootle Corporation and the Waterloo District Electric Co., and partly to the bulk supply provided for Prescot and district. Output increased from 86 333 510 kWh in 1920, to 172 044 688 kWh five years later. The maximum peak load rose from 33 317 kW to 73 614 kW during the same period. In 1922 it became necessary to consider further extensions of generating plant and the decision was taken to extend the Lister Drive site, where space was available for an additional 100 000 kW. Arrangements were made for the plant to run on oil fuel during the first summer of operation but both coal firing and oil burning could be employed.

The cooling towers were of a type new to this country and were originally developed in Holland.

A paper by J. R. Beard, M.Sc., *(M)*, and T. G. N. Haldane, B.A., *(Grad)*, entitled 'The design of city distribution systems, and the problem of standardization' was read on the 22nd December 1926.[17] The authors sought to analyse city distribution methods, to determine a policy of development, and consider the possibility of standardisation in view of an expected rapid growth of load, and particularly the domestic load. Their primary aim was to design a suitable system for adoption as a standard and to consider how existing systems could gradually be brought into line with the proposals. But compared with later developments growth was very slow at the time.

In any review of the work of 19th century scientists the name of Michael Faraday is paramount. Born of humble parents in Yorkshire in 1791, he went to London and was apprenticed to a bookseller at the age of 13. Following attendance at a course of lectures given by Humphrey Davy (1778–1829) at the Royal Institution, London, he applied for, and shortly afterwards obtained employment as Davy's assistant, whom he succeeded as director of the laboratories in 1825. Faraday was an outstanding experimentalist. His discoveries in electricity and magnetism laid the foundation for the development of the electrical engineering industry.[18] Faraday retained his connection with the Royal Institution until he died at Hampton Court in 1867.

The Faraday Lecture was inaugurated by the Council of the Institution in 1923. Its purpose is to increase the general public's interest in electricity and to make the work of the Institution more widely known. At the same time it serves to comemorate the life of Michael Faraday. The lectures are delivered in London each session and at selected cities in the provinces. The first lecture was given by Prof. G. W. O. Howe in 1924–25, and was entitled 'Worldwide radio telegraphy'. It was followed by 'Illumination and light' by A. P. Trotter, B.A., in 1925–26, delivered in Liverpool in January 1926. The 3rd Faraday Lecture, and the 2nd to be provided at the Mersey & North Wales Centre, entitled 'What is electricity?' by Prof. W. M. Thornton, O.B.E., D.Sc., D.Eng., Vice-President of the Institution of Electrical Engineers, was given on the 10th January 1926.[19] Incidentally, Prof. Thornton was born in Liverpool in 1870. He received his early

education at the Liverpool Institute and left at the age of 14. After eight years in employment he entered University College, Liverpool, and graduated with honours in physics and engineering. He then left the area. In 1934 he was elected President of the Institution. He died in 1944.

In his lecture Prof. Thornton contended that the electrical researches of Faraday were changing the face of civilization. Through him, in the work of Maxwell, Hertz, Lodge and others, radio telegraphy and telephony had developed. He was the father of electrical engineering. But nobody knew what electricity was, and Prof. Thornton said he proposed to offer a solution which gave a close analogy to what must be, and could provide, a basis for mathematical treatment. He divided his lecture into three main parts: providing evidence first, that the two units of electricity have the nature of screws or twists; second, how the screws came into being, and third, that through their vibrations they give rise to electrical radiations which results in light and heat. The true nature of electricity had, of course, to await further experimental work in the field of nuclear physics.

Two complementary papers were read at the meeting held on the 21st March 1927. The first was entitled 'Illuminating engineering' by J. W. T. Walsh, M.A., D.Sc., *(AM)*, who defined illuminating engineering 'as that branch of applied science which deals with the generation, distribution and use of visible radiation'.[20] The author held the view that the lighting load provided at the time could have been at least quadrupled with the resulting benefit to the community. In his concluding remarks Dr. Walsh included the comment that '90% of people in this country carry on their after daylight hours by an inadequate illumination and an unsuitable system of lighting'.

The author of the second paper entitled 'The Problems of public lighting by electricity', was Lieut.-Cdr. Haydn T. Hanson, R.N.V.R., *(M)*, who felt that in the public lighting field conditions had not altered very much since 1913.[21] He proposed that light sources should be centrally suspended at frequent intervals by means of span wires which – to reduce costs – should support the conductors.

It is interesting to note that electricity sales for public lighting in 1925 amounted to 43 million kWh, compared with 164 million kWh in 1947, and 1513 million kWh in 1971–72.

1927–28

Prof. F. J. Teago, D.Sc., became Chairman for the 1927–28 Session. He chose the subject 'The slip-ring and the commutator' for his Chairman's Address, (see Fig. 30), which was delivered on the 24th January 1927.[22] Prof. Teago held the post of Lecturer at the University of Liverpool from 1912 to 1926, when he was appointed to the Chair of Electrical Machinery. In 1946, the title was changed to the Chair of Electrical Engineering (Electrotechnics) until 1952, when the title became the Robert Rankin Chair of Electronic Engineering. Prof. Teago occupied the chair until 1952.

The 4th Faraday Lecture by S. Z. de Ferranti, D.Sc., F.R.S., Past-President of the Institution, entitled 'Electricity in the service of man', was delivered in Liverpool on the 20th February 1928.[23] The lecturer gave an historical survey beginning with the invention of the galvanic battery and reviewed its various applications. The electric telegraph, electric lighting, motive power, and railway electrification, all commenced to function through current supplied from a battery. Dr. Ferranti then proceeded to describe the invention and development of the dynamo and transformer, and discussed London's Tubes, and mainline electrification. He dealt also with the domestic use of electricity and took an interesting look into the future.

In March, 1928 a paper was given on 'Modern electric wiring, particularly as applied to small houses' by D. S. Munro *(M)*.[24] It consisted of two parts. Part 1 reviewed modern wiring methods, and part 2 considered the layout of wiring in small houses. The author stressed that the largest section of skilled workers in the electrical engineering industry was engaged on installation work. He considered that British house wiring from 1880 to 1914 was superior to that prevailing in other countries, but the 1914–18 war had led to the introduction of many unskilled workers, shoddy material and wasteful methods. On the other hand, manufacturing processes had improved with the result that reliable wiring material and accessories had become available. Gas was often adopted for housing schemes after the war and trivial and inadequate wiring was often fitted in others. The author went on to say:

> 'Now, however, there are distinct signs of improvement. Better buildings are demanding better installations, and the coal strike (which occurred in 1926 and led to the General Strike), perhaps more than anything that has happened, has convinced the public that a substantial and well-fitted electrical installation is a most desirable investment'.

In 1925 the average consumption of electricity per domestic consumer was 520 kWh. The figure rose to 1190 kWh in 1947–48, and 4220 kWh in 1971–72.

The author also mentioned another change, namely that the motor vehicle had become:

> 'the accepted medium for the transport of labour, material and tools to installations and eliminates the goods train, which is one of the chief objections to the use of conduits in outlying districts'. The author said also he would 'welcome the foundation of a body of trained and certified wiring inspectors with power to visit, test and inspect old as well as new installations . . . Inspectors acting with authority would improve the wiring industry and further the adoption of national rather than local rules'.

1928–29

The Chairman of the Centre for 1928–29 was Mr. S. E. Britton, a pioneer and outstanding personality in the field of rural electrification. In 1930, only 2 million kWh of electricity were sold to farmers. In 1947 the figure increased to 215 million kWh, and in 1971–72, it rose to 3014 million kWh.

Mr. Brittin acted as Engineer and Manager to the Chester Electricity Undertaking for 42 years. He was responsible for the erection of the hydro-electric station mentioned in Chapter I, and for a 33 kV overhead line from Queensferry to Chester in 1922.[25] Mr. Britton chose the subject 'Rural electrification' for his Chairman's Address, which he delivered at the meeting held on the 22nd October 1928.[26] He discussed the various Acts of Parliament dealing with electricity supply and the need to extend the supply of electricity to rural areas. He emphasised the benefits conferred on the rural community and the farming industry when supplies of electricity became available.

In January 1929, a paper on 'Overhead electric lines: an account of the work of the British Electrical & Allied Industries Research

Association' was read by W. B. Woodhouse, a Past-President of the Institution.[27] The paper recorded the comprehensive research undertaken by the BEAIRA into the problems arising in the construction and uses of overhead electric lines. Wooden poles, both single and compound, were tested, and the intensity of wind pressures on wires and cables; and on the poles and lattice structures used for supporting them. The data obtained made it possible to estimate with reasonable accuracy the wind pressures on various structures, whereas previously results were based only by rule of thumb.

A major advance in the construction of simple but effective h.v. overhead lines occurred with the introduction of BS1320 in 1946.

Llewellyn B. Atkinson, Past-President of the Institution, visited Liverpool on the 18th February 1929, to deliver the 5th Faraday Lecture, entitled 'How electricity does things'.[28] The lecturer covered such topics as the structure of matter, the action of detached electrons, electric motors and dynamos, alternating currents, radiation and waves.

1929–30

Prof. E. W. Marchant, D.Sc., was elected Chairman of the Mersey & North Wales (Liverpool) Centre for the 1929–30 Session. He was, of course, the first Chairman when the Sub-Centre was formed in 1919. His Chairman's Address entitled 'Science and Electrical Engineering' was given on the 21st October 1929.[29] The speaker, having in mind the approaching centenary 'of the discovery by Faraday of the way in which an electric current can be generated by the movement of a magnet near to a coil of wire', thought it appropriate to survey the progress of electrical engineering which had resulted from scientific discoveries. He then proceeded to give an account of electromagnetism, cable telegraphy, telephony, high-frequency currents and wireless telegraphy, electrical engineering materials, distribution networks, and measuring and recording devices. At the conclusion of his address, Prof. Marchant said:

> 'Scientific discovery is the basis of all electrical engineering: without it the electrical industry would not exist. It is as necessary that it should be encouraged today as ever it was, for the discoveries of tomorrow may lead to as great a material revolution as did those of Faraday'.

His judgment was not at fault.

In the 'Report of the Council for 1929–30' [30] it was recorded that:

> the 'delivery of the President's Inaugural Address on the 24th October 1929 was marked by the fact that by means of telephone land-lines and loud speakers it was heard simultaneously at meetings of members in London, Birmingham, Cardiff, Glasgow, Leeds, Liverpool, Manchester, Newcastle on Tyne, Portsmouth and Southampton. At the commencement of proceedings the Chairmen of all meetings spoke in succession and were clearly heard by the 10 audiences'.

The President of the Institution was Sir Thomas Purves.

Another innovation was brought to the attention of the Centre when the paper entitled 'The heating of buildings electrically by means of thermal storage', by Lt.-Col. S. E. Monkhouse, R.E.(T.R.), *(M)*, and L. C. Grant, *(M)*, was read at the meeting which took place on the 9th December 1929.[31] The authors pointed out that considerable progress had been made with forms of electrical heating in recent years. They compared the higher cost of electrical energy with the cost of solid or liquid fuels, and stated that the former was compensated by the advantages of cleanliness, convenience and efficiency. They advocated an extension of electrical heating by the adoption of thermal storage, which would permit energy to be used during off-peak hours. They contended that such a system would be economical to operate, and showed that for large buildings, electrical heating could compete with systems employing other forms of fuel.

Members and visitors who attended the meeting on the 17th March 1930, to hear H. H. Harrison, *(M)*, read his paper on 'Developments in machine telegraph systems and methods of operation' were rewarded by being able to listen to a comprehensive, informative and well illustrated paper, with the addition of a useful bibliography.[32] The author remarked that the design and operation of machine telegraph systems had been affected considerably

> 'in recent years by the production of high-speed communication links of the trans-oceanic order of length, and by new methods of operation on land lines enabling the line plant unit – the telephone pair – with its series loading and its repeater stations *en route*

to be used for either the transmission of telegraph signals or speech, or both, simultaneously and independently'.

In his introductory remarks the author had commented that the development of both the apparatus employed and the methods of operation had been extraordinarily extensive. The use of the 5-unit code had been extended to transatlantic cables 'while radio telegraphy has reached a position in which it has to be acknowledged as a serious rival to the older, established, means of long-distance communication'. The rivalry between wire and radio telegraphy had stimulated workers in both fields. One result was that submarine cables had greatly improved in traffic-carrying capacity. Mr. Harrison remarked:

'In the field of radio telegraphy the beam system of Marconi is fulfilling all the possibilities predicted for it . . . we are now in possession of many communication links of the order of several thousand miles in length characterised by reliability and operating speeds held, until quite recently, to be impossible over such distances'.

Rapid communication with remotely situated points had become commonplace.

1930–31

A. J. Pratt delivered his Chairman's Address on 'The Development of the telephone system' in October 1930.[33] He commenced by stressing the widespread use of the telephone and the efforts being made to improve both audible and visible electrical communication. It was practicable for 90% of the civilised peoples 'to enjoy the facilities of international telephony'. After giving a brief historical survey of the subject Mr. Pratt discussed the future of manual exchange plant. 'It would,' he said, 'be rash to foreshadow the closing of the last common-battery (manual) exchange'. On the other hand, considering the employment of automatic exchange plant, he expressed the view that

'Whatever may be said in praise of the simplicity and effectiveness of the common-battery method of working an exchange the ingenuity expressed in the mechanical and electrical devices utilized in an automatic exchange of either the direct-switching or director system of working is of a superlative order . . . '

When the paper was read there were some 25 director and 100 non-director automatic telephone exchanges in the country, including some opened between 1912 and 1924 employing other automatic systems, e.g., the Automatic Telephone Co.'s Strowger step-by-step system. In his concluding remarks, Mr. Pratt placed on record

'the fact that the first automatic branch exchange in Liverpool (of the really automatic type, with public exchange connections) was installed at the offices of our enterprising local press in Victoria Street, and opened for service in January, 1922'.

Figs. 31 and 32 show examples of manually-operated exchanges at Liverpool and Bradford. Details of the first Strowger switch are shown in Fig. 33. The evolution of the Strowger switch can be seen in Fig. 34. Fig. 35 illustrates some early telephone instruments.

The 7th Faraday Lecture was given in Liverpool on the 16th February 1931, by Prof. W. Cramp, D.Sc., *(M)*, entitled 'The birth of electrical engineering'.[34] It showed the sequence of ideas as they grew in the mind of Michael Faraday, the 'father of electrical engineering.' The author had studied the manuscripts and records of Faraday which were available in the archives of the Royal Institution in London.

1931–32

The Faraday Centenary Celebrations, organized by the Institution of Electrical Engineers, took place from the 21st to the 24th September 1931 in London and elsewhere. It was in August 1831 that Faraday conducted experiments which led to the discovery of the phenomenon of magnetic induction. The Exhibition in London was held at the Royal Albert Hall.

In Liverpool the Centre Committee and the British Electrical Development Association organized an exhibition at the Picton Hall, from the 21st to the 25th September. Members of the Students' Section took charge of the paybox arrangements. The exhibition, which was attended by 17 000 people, consisted of apparatus illustrating Faraday's discoveries, and various modern applications. A luncheon was held on the opening day, at the Adelphi Hotel, Liverpool, which was attended by the Lord Mayor of Liverpool and representatives of many public authorities and electricity undertakings.

P. M. Hogg's Chairman's Address delivered in October, 1931, was on 'The application of electricity to measurement of Temperature', and dealt with industrial pyrometry.[35] The speaker concluded that, as the success of many industrial processes depended on temperature control;

> 'the application of electricity to the measurement of temperature gives the electrical engineer an excellent opportunity of increasing his usefulness in the industrial world'.

In December 1931, a paper entitled 'The Design of a Distribution System in a Rural Area' by E. W. Dickenson, *(M)*, and H. W. Grimmitt, *(Assoc)*, was presented to the Centre.[36] The authors reviewed the existing stage of rural development and discussed the general considerations affecting the design of equipment. An abstract 'model scheme' was employed, embracing an area of 400 square miles, in order not to limit unduly the scope of the paper. The authors were convinced that based on available statistics and data, electrification of sparsely populated rural areas was a practical proposition, both technically and financially.

The Faraday Lecture, entitled 'Ordinary applications of electricity', was given by Prof. J. K. Catterson Smith, M.Eng., on the 15th February 1932, in the Arts Theatre, at the University of Liverpool. The attendance was 850 persons, which filled the hall. Having received some 1700 applications for tickets, and in view of the increasing popularity of the lectures in recent years, the committee had arranged to take a larger hall for the lecture to be given next year.

The 'Report of the Committee for the Session 1931–32', recorded with pleasure that Prof. E. W. Marchant was to be the next President of the IEE. The report stated:

> 'Ever since the beginning of his connection with the IEE in 1898, Prof. Marchant has been an active member of the Institution. He was Chairman of the North-Western Centre from 1914–16 and was instrumental in starting the Liverpool Sub-Centre, (of which he was the first Chairman) which afterwards became the Mersey and North Wales (Liverpool) Centre, of which he was Chairman in 1929–1930'.

The Students' Section had a very successful session, which included a unique joint meeting of Students' Centres on the 27th February 1932, when members of the Manchester, Liverpool and Sheffield

Centres, totalling 114, visited Metropolitan Vickers Electrical Co. Ltd., at Trafford Park, concluding with a visit to a theatre.

1932–33

In October 1932, the incoming Chairman, A. C. Livesey, gave his address entitled 'Some aspects of the electrical industry in Relation to Great Britain's Economic Position', at the University of Liverpool.[37] The author examined the position of the electrical industry with reference to exports, research and development, manufacture, marketing and distribution. He pointed out that notwithstanding the worldwide depression, there had been a steady expansion of the business of power supply. Mr. Livesey mentioned that manufacturers tended to embark on producing an increasingly wide variety of machinery and plant. He suggested that this tendency should be checked to ensure efficiency and economy. With regard to marketing and distribution he agreed that the disposal of goods abroad was a complex problem. Apart from the large firms the industry was not organized for export trading. He made the suggestion that co-operative schemes should be used to ensure an efficient marketing and distribution organization. This was being tried in South America by a number of British manufacturers, and he hoped that it would be successful.

In his Presidential Address, delivered before the Institution in London, on the 20th October, 1932, Prof. Marchant (Fig. 36) dealt with a number of topics.[38] They included the education and training of electrical engineers, examinations, national certificates, scholarships, research, electrical measurements, the development of heavy electrical engineering, electric power in the tropics, light current electrical engineering, electricity in medicine, and matters concerned mainly with Institution affairs. Finally, he discussed the possibility of increased co-operation between engineering institutions and, with some foresight, suggested:

> 'that the time is not far distant when electrical engineers, mechanical engineers, and the venerable civil engineer, should attempt to form one greater guild, the nucleus of which already exists in the Engineering Joint Council'.

Prof. Marchant's wide-ranging address gave a clear indication of his

breadth of interest in education and engineering, and also his broad vision.

In a letter dated the 14th November 1932, addressed to each member of the Centre, Mr. Livesey, as Chairman of the Mersey & North Wales (Liverpool) Centre, stated that it was not often that a member of the Centre enjoyed the honour of being elected President of the Institution of Electrical Engineers. That honour had fallen upon Dr. Marchant, and through him on the Centre. The Committee had decided to pay tribute to the distinction that Dr. Marchant had earned and to make him some suitable presentation as a momento of the occasion. He therefore appealed for subscriptions (of limited amounts) from the various grades of member.

Prof. Marchant was presented with a radio gramophone at the Annual Dinner held on the 28th November, 1932. On the following day he wrote a letter to the Honorary Secretary, thanking the members for their gift. One paragraph read:

> 'The only regret I have is that I am afraid some members of the Centre who have subscribed to the gift may have felt obliged to do so at a time when things are difficult for many of them financially. I should like to assure you once again however, how much I value the gift'.

On the 21st November, 1932, R. P. Smith, *(AM)*, read a paper on 'The inland telegraph service: the introduction of modern machinery and methods'.[39] In his introduction the author stated:

> 'During recent years the telegraph service of Great Britain has been the subject of prolonged and exhaustive study, with a view to making it more attractive to the public, more efficient as a means of communication, and less costly as regards the loss of State revenue'.

Mr. Smith quoted some interesting statistics. For instance, in 1919 the service dealt with 355 353 telegrams, which constituted a record. In 1931 the Post Office handled 37·6 million inland telegrams. In 1932 there were 11 400 telegraph offices in Great Britain and Northern Ireland. The first teleprinters were obtained from America and used by the Post Office in 1922, on a circuit between two London offices. The instrument in use at the time the paper was read was the teleprinter no. 3A, first used between London and Colchester in 1928. Since then some 2200 instruments had been put into service.

The Annual Dinner was held on the 28th November 1932, at the Adelphi Hotel, and included a programme of music by the Adelphi Trio. Prof. Marchant, as President, responded to the toast of the Institution, proposed by Councillor Alfred Gates, J.P., The Lord Mayor of Liverpool. During the course of his speech he said he felt that the reason that electrical engineering had maintained its position during the long depression was largely due to the Grid. He foresaw the great benefit the Grid would provide in the future. He could not accept the suggestion that electricity tended to increase unemployment, but the reverse. Unemployment could not be cured by refusing to use labour-saving devices. The result would be that we should fall behind.

The 9th Faraday Lecture entitled 'Lightning – and how the engineer deals with its effects', by Prof. J. T. MacGregor-Morris, was given in the Central Hall, Renshaw Street, Liverpool, on the 13th February 1933. The lecture was illustrated by means of lantern slides, exhibits and demonstrations.

At the 96th Committee Meeting held on the 13th March, 1933, the Committee recommended that to fill the vacancies occurring on the Committee at the end of the session the Chairman should be B. Welbourn; R. G. Devey and O. C. Waygood, Vice-Chairmen; L. Breach, Honorary Treasurer; O. C. Waygood, Honorary Secretary; and W. Parry, Hon. Assistant Secretary. Mr. Waygood, who had acted as Honorary Secretary since the formation of the Sub-Centre in 1919, up to the present time, had intimated that he wished to relinquish his duties as Honorary Secretary. However, he agreed to continue during the 1933–34 Session, after which Mr. Parry would succeed him. Meanwhile it would be noted that Mr. Waygood had been nominated to serve as a Vice-Chairman.

Following the Committee Meeting an Ordinary General Meeting was held and a paper entitled 'An analysis of the costs of electricity supply and distribution in Great Britain, with some suggestions as to their causes and remedies for the slow rate of development' was presented by J. N. Kennedy, *(M)*, and Dorothy M. Noakes, B.Sc., *(Grad)*.[40] The paper was read by Miss Noakes. The authors argued that the generation side of the electrical engineering supply industry had shown a very progressive tendency during the past ten years, in the fields of technical design, and the efficient operation of generating

stations. The construction of the Grid, coupled with the co-ordinated control of generation by the Central Electricity Board would 'shortly possess the most efficient instrument in the world for the generation and transmission of electricity in bulk'. On the other hand, the distribution side had shown little, if any, real improvement in the efficiency of distribution in the period under review. There were seven different voltages, both a.c. and d.c., and the number of different tariffs was almost as great as the number of supply undertakings. The authors proposed that distribution powers over wide areas should be placed in the hands of single authorities. Area Boards might be favoured. The important thing to ensure the rapid expansion of electrical development was to co-ordinate distribution. It should be noted that in 1932 the number of domestic consumers was less than 4 million, compared with nearly 17 million in 1971–72.

At the conclusion of the first decade of its existence, the Mersey & North Wales (Liverpool) Centre had 500 members, made up of 59 Members, 197 Associate Members, 55 Associates, 77 Graduates, and 112 Students. It served an area bounded by straight lines between Southport, Wigan, Warrington, and in the direction of Wrexham, up to the county boundary. It served also the counties of Flint, Denbigh, Merioneth, Montgomery, Caernarvon, and the Island of Anglesey.

The Students' Section had continued to grow throughout the decade. In addition to regular meetings for the discussion of papers, visits were arranged locally to places of engineering and general interest. An annual dance was organized and members of the Section supported the annual dinner arranged by the Centre.

The Annual Golf Competition for the G. P. Dennis Trophy, in aid of the Benevolent Fund of the Institution of Electrical Engineers, was a very popular event.

There was no doubt that the creation of the Centre had been fully justified. The quality of the papers read at meetings continued at a high level. The attendance at meetings was good and the percentage of active members was relatively high, considering the total number. The experience of the first ten years augured well for the future.

CHAPTER 6

1933–39 A PERIOD OF CONSOLIDATION

The six years preceding the Second World War was a period of development in the electrical engineering industry which included the commencement of television broadcasts from Alexandra Palace in November 1936, 14 years after the British Broadcasting Co. had been established. The 1930s also saw a number of technical advances in the electronics industry which paved the way for radar, other navigational aids, and defence equipment, which later proved to be of considerable value to the war effort.

In 1933 the Mersey & North Wales (Liverpool) Centre had been in existence for ten years. The period under review can be considered one of consolidation. The Centre's programme evolved into a pattern of learned-society activities together with a limited number of social functions, which included an annual dinner, and the annual golf competition in aid of the Benevolent Fund. Many of the papers read at Centre meetings dealt with factors of national importance, and a minority considered a particular aspect of the application of electricity on an overseas or international basis. This chapter is primarily concerned with the papers read at meetings during 1933–39.

1933–34

B. Welbourn, who had occupied the Chair in 1922–23 when the Centre was formed, was again Chairman for the 1933–34 Session. He took as the theme of his address 'Load-building for the Grid', which was delivered on the 23rd October 1933.[1] The Grid had been constructed under the Electricity (Supply) Act 1926 at a cost of £27-

million sterling, to which had to be added another £19-million for the change of frequency to ensure the availability of a 50 Hz supply throughout the chief centres and the main areas of England, Wales and Scotland. At this stage, the author stated, some Central Electricity Board areas were already operating as complete units. The purpose of the scheme was to interconnect the principal generating stations throughout the country 'in which the generation of all supplies required by authorised undertakers is to be concentrated'. In addition to standardising the frequency of supply, the Central Electricity Board aimed to accelerate the growth of output by providing abundant (and if possible cheap) supplies of electricity throughout the country.

Mr. Welbourn then examined the industrial load which rose from 14·2 million hp in 1924 to 16·3 million hp in 1930, while nonelectric power declined from 49% to 39%. During the same interval motors driven by purchased electric power increased from 29% to 36%, and those driven by private generators increased from 22% to 25%. The figures show that a large amount of power-driven machinery remained to be converted to electrical operation. The author also mentioned that, in a recent issue of *The Times*, it was stated that less than 4000 farms were provided with electricity out of a total of 470 000. In addition to rural electrification, he also dealt with the application of electrochemical methods.

The recommendation included in the Weir Report, published in 1926, that there should be a complete electrification of the railway system, led Mr. Welbourn to suggest that, with increased passenger traffic, fares could be reduced. The electrification of the Manchester–Altrincham line in 1931 had enabled the railway to offer a 25% improvement in scheduled speeds, despite the fact that three new stations had been constructed. The speaker then discussed the use of electricity in the mining industry, and came to the conclusion that it offered opportunities for a considerable extension. In 1924 the steam engines and turbines driving plant in coal mines developed 3 088 478 hp. Six years later the figure had declined to 3 001 830 hp. During the same period the use of electric motors had increased and the equivalent figures were 1 644 588 hp in 1924, and 1 902 895 hp in 1930. The total consumption of electrified railway lines in Britain in 1932 amounted to 1,107 x 10^6 units.

Towards the end of his address, Mr. Welbourn said that 'Domestic consumption provides the most stable of all loads, and the one with the largest possibilities of expansion in the immediate future'. He forecast that total sales by 1940 would reach 20 700 x 10^6 units, which would be equivalent to a growth rate of 1400 million units per annum. As a matter of interest, the actual sales reached by 1940 were 21 822 x 10^6 units.

A paper entitled 'the application of automatic voltage and switch control to electrical distribution systems' by W. Kidd, *(M)*, and J. L. Carr, B.Sc., *(AM)*, was read at a meeting in November 1933.[2] It dealt with what the authors considered one of the most interesting problems which an engineer engaged on electrical transmission had to solve. They considered urban, as distinct from rural, supply and were concerned primarily with Manchester, which was considered to be the first area to have completely automatic voltage regulation.

During the session, the Faraday Lecture entitled 'The electrcial engineer and the Free Electron' by Clifford C. Paterson, O.B.E., was delivered in Liverpool.

1934–35

The Centre Chairman for the 1934–35 Session was R. G. Devey. He took as the title of his Chairman's Address 'Electricity in industry', which was delivered on the 15th October 1934.[3] The author dealt with the problems arising from the utilization of electricity with special reference to industry. He outlined the means of obtaining electricity and considered some of the more important phases in connection with its use in factories. Three of the tables (Tables 1, 3 and 4) he included in the paper are of interest. They provide statistical information relating to the occupational distribution of population, electrictiy sales in 1931–32, and a comparison of the use of mechanical and electrical power in industry respectively.

Although the Mersey & North Wales (Liverpool) Centre was based on a large port, there is very little reference to either the port or the utilization of electrical energy in the field of marine engineering, in papers read at meetings. Therefore, the paper entitled 'Generation, distribution, and use of electricity on shipboard' by C. Wallace Saunders, *(AM)*, H. W. Wilson, *(AM)*, and R. G. Jakeman, D.Sc.,

TABLE 1

Occupational Distribution of Population

Occupation	*Great Britain* (1931)	*U.S.A.* (1930)	*Germany* (1925)	*France* (1926)
Manufacturing industries, commerce and transportation	74·8	56·2	57·8	50·4
Agriculture, forestry and fishing	6·6	22·0	30·5	38·3
Other occupations	18·6	21·8	11·7	11·3

TABLE 3

Sales of electricity by authorised undertakings in Great Britain for the year 1931–32

	kWh x 10^6
Public lighting	183
Traction	811
Domestic	3071
Industrial power	5435

TABLE 4

Percentages of mechanical and electrical power in industry

	1907	1924	1930
Electrical	16·4	54·6	66·0
Mechanical	83·6	46·4	34·0

* The 1907 Census included Great Britain and Ireland. The 1924 and 1930 figures do not include the Irish Free State (now Eire).

Mr. Devey concluded that:

'electricity is taking an increasingly large part in industrial life owing to its higher efficiency, lower cost of application and operation, and greater convenience when compared with competing forms of energy'.

(M), read at a meeting held in January 1935, is an exception.[4] The authors discussed the use of electricity on board merchant ships, and the systems of generation employed. The electrical equipment commonly used was surveyed, and refrigerating methods were reviewed. The time had come when the use of electricity for auxiliary purposes was taken as a matter of course, but it was only after the advent of the diesel engine that electricity had been extensively used for purposes other than lighting. The authors reported that great progress had been made in the field of electric propulsion. In 1931 the power of electrically propelled ships at home and abroad, including all nationalities, had reached a total of 1 million shp. During that year British yards alone had turned out first-class passenger-carrying tonnage totalling 70 000 shp. The authors held the view that turbo-electric drive was the most suitable for propelling large ships. They paid tribute to the electrical industry for supplying electrical equipment acceptable to marine engineers without criticism as to its reliability for many years.

Prof. E. W. Marchant, D.Sc., gave the Faraday Lecture this session. He chose as his subject 'Electricity in the Life of Today'. Liverpool was included in the towns visited.

1935–36

Mr. Oscar C. Waygood, who had acted as Honorary Secretary from the inception of the Sub-Centre, and then from the setting up of the Centre, was elected Chairman for the 1935–36 Session. His Chairman's Address was given in October 1935, and considered 'The engineering problem in a modern store'.[5] In his introduction he stated that on average each retail store consumed some 300 000 units of electricity annually. The range of consumption varied from 3000 to 8 million units per store and proved of considerable interest to those engaged in the electricity industry.

In the concluding part of his address, the author wondered whether the best use was being made of the Grid. He considered that progress during the postwar years had been phenomenal. Although great strides had been made in lighting, it was only on very set lines. Cooking by electricity had been tackled in a half-hearted manner. Standardization was something one still dreamt about.

In 1935 the average consumption of electricity per domestic consumer amounted to 500 kWh. The figure rose to 1190 kWh in 1947–48, compared with 4220 kWh in 1971–72.

The results of experience with new equipment were given in a paper entitled 'Equipment and performance of steel-tank rectifier traction substations operating on the underground railways of the London Passenger Transport Board' by A. L. Lunn, *(M)*, which was presented in January 1936.[6] The author commenced by giving a brief description of the rectifier substations recently constructed on the Underground Railways of the LPTB. The trial plant consisted of a British made 1500 kW, 630 volt equipment which was put into service in 1930. Following its success contracts were placed for plant having a total capacity of 55 000 kW, composed of 1500 kW and 2000 kW units, all of them remotely-controlled. The first unit was commissioned in 1932. During the intervening period the standard of reliable service had been highly satisfactory.

H.M. King George V, Patron of the Institution of Electrical Engineers, died in January 1936. At a special meeting held on the 30th January, the President and the Council of the Institution passed a Resolution which recorded:

> 'their sense of the profound loss which the Empire has sustained through the lamented death of His Most Gracious Majesty, King George V, and their deep regret that the reign of one who dedicated himself to the service of his people and who led them with wisdom, dignity, and devotion through perilous days, has been brought to a close.
>
> 'The beneficent influence which he exercised in the promotion of world peace and in securing international friendship and goodwill, and the great services which he rendered to the Empire, won universal esteem and affection. The members of the Institution of Electrical Engineers have also a more personal ground for their regret, in that since the year 1921, when a Royal Charter of Incorporation was granted, he had been graciously pleased to be the Patron of the Institution.
>
> 'The Council humbly beg permission to express to His Majesty King Edward VIII, Her Majesty Queen Mary, and the members of the Royal Family, their profound sympathy, and further to lay before His Majesty the assurance of their unswerving loyalty and devotion and their earnest wish that his reign may be long and prosperous'.

A paper by E. R. Kaan, entitled 'Main-line electrification throughout the world, with special reference to the Austrian Federal Railways', was given at a meeting held in April 1936.[8] In his introduction, the author stated that he had 'been in close contact with the great majority of the railway electrical engineers in most countries of the globe'. Nearly all the railways were in a more or less precarious position, mainly owing to the existing economic conditions and the slump in world trade. The railways had lost the monopoly of land traffic. They had competitors not only for goods but for passengers in road traffic, and there was also air traffic to consider. This was not an isolated but an international problem. The introduction of electric traction had helped the railways to improve their economic position by reducing costs, increasing the capacity of the system, and raising train speeds.

The author explained that two systems were employed for electric traction on main lines. The first was the single-phase a.c. system, generally at $16\frac{2}{3}$ Hz, and a voltage at the contact line of 15 kV. The second system was d.c., normally at a voltage of 3000 or 1500, using overhead equipment. In addition, the 3-phase system of 3600 V, using overhead equipment was employed in some instances. The latest system to be introduced was a 3-phase, 50 cycle supply by conversion on locomotives, or in substations, by means of grid-controlled mercury-arc rectifiers in both cases.

Mr. Kaan then proceeded to describe the situation in 30 countries. Switzerland had made more progress with electric traction than any other European country. Very few steam locomotives continued to be used. In Great Britain the work undertaken by the Southern Railway (now the Southern Region of British Rail) – the electrification of the London suburban lines and the lines to the south coast – 'has aroused the author's greatest admiration'. In the United States less than 1% of the 262 500 miles of lines in the country had been electrified. In Japan electric traction dated back to 1895, but since then only 2·3% of the State lines, and 58% (equivalent to 4200 miles) of the branch lines, had been electrified.

In 1936, the interests of the Institution included a Meter and Instrument Section with 638 members, a Transmission Section with 1621 members, and a Wireless Section with 782 members, all based

at headquarters. The total membership of the Institution stood at 16 788.

The Faraday Lecture was delivered by Dr. E. Mallett, who chose as his subject 'Television – an outline'. His itinerary included Liverpool.

1936–37

'The Domestic Load' was the subject of the Chairman's Address, given by Mr. F. E. Spencer, in October, 1936.[9] The domestic load was playing an ever increasing part in the lives of the people of this country. Domestic help was difficult to obtain, and this factor had contributed to the rapid growth of the domestic load in recent years. In 1935 electricity sales in the domestic field amounted to 2944 million kWh, whereas in 1920 the figure was 271 million kWh. In 1971–72 the total reached 70 113 million kWh. Mr. Spencer went on to say that the conditions of life had also altered considerably.

> 'Twenty or thirty years ago people stayed at home doing housework, whereas in these days of motor cars, attractive road houses, and swimming pools, very much more time is spent in the open air'.

The author contended that electric labour-saving devices had contributed very largely to this state of affairs. The fashion, only a few years ago, for the advocates of other forms of cooking to ridicule the competition of electricity, and their attitude of amused tolerance had now turned to one of distinct alarm. The housewife thought not only of quarterly bills, but of other factors, such as cleanliness, health, and the saving of labour. The immersion heater or circulator, fitted as an auxiliary to the ordinary household hot-water apparatus had become popular. Electric heating was well established, but

> 'The love of an open fire which can be poked is ingrained in the Englishman, and it will be many years before that form of heating is displaced'.

A paper presented in December 1936 provided details of many engineering developments that had taken place in the inland telegraph service of the British Isles during the past few years. It was entitled 'Recent developments in telegraph transmission, and their application to the British telegraph services' by L. H. Harris, M.Sc., E. H. Jolley, and F. O. Morrell, B.Sc.[10]. The major development was the conversion

of the main telegraph systems of the British Isles to multichannel voice-frequency working. This resulted in the unification of the telephone and telegraph line plant. Telegraphy had attained a position which permitted it to share in the rapid advances made in the telephone field. Continuous progress was assumed in the private teleprinter services.

In the 'Report of the Council for 1936–37,' it is recorded that King Edward VIII had become Patron of the Institution in May 1936.

During the session the Faraday Lecture entitled 'Electricity in the hospital' was delivered by R. S. Whipple, and given in Liverpool.

His Excellency the Marchese Marconi, G.C.V.O., LL.D., D.Sc., the man who 'had seen wireless grow from an idea–of the practical value of which he alone was originally convinced – into a world–wide means of communication affecting the life of every individual', died in Rome on the 20th July 1937. In 1897, when the youthful Marconi formed his company, wireless messages could be sent and received over a distance of about ten miles. In 1901 messages could be sent across the Atlantic. Twenty-seven years later, a chain of wireless beam stations linked the British Empire. Marconi became a Member of the Institution of Electrical Engineers in 1898, and was elected an Honorary Member in 1926. 'The first scientific paper which he read in this country was that, before the Institution on the 2nd March, 1899, entitled 'Wireless telegraphy', for which he was awarded the Fahie Premium'.[11]

1937–38

'The problem of rural electrification' was the title of the Chairman's Address, given to the Centre in October 1937, by G. K. Paton.[12] The author dealt particularly with the problems encountered in North Wales. There was a great diversity of rural conditions in the North Wales & South Cheshire Electricity District. Cheshire was a rich farming county but in North Wales there were widely scattered farms and large areas of mountain land, which influenced the commercial aspect of electricity supply. Although considerable development had already taken place throughout the North Wales and South Cheshire area, the problem remained how to develop the very thin areas with a limited demand for supply and to offer an attractive tariff. The author held the view that:

'the extent to which further development can be made in rural areas will depend on the margin of profit which can be earned in the more densely populated part of the area to recoup the losses in the early years of development in the rural areas'.

At a meeting held in March, 1938, two papers were read dealing with domestic electric cookers. The first paper, by O. W. Humphreys, B.Sc., was entitled 'The design of domestic electric cookers'.[13] The opinion was expressed that although electric-cooker development during the last quarter of the century had been proceeding on sound lines, the next few years would see important changes involving both general appearance and oven design. It was clear that thermostatic oven control was gaining in popularity. New problems were arising in connection with oven heating, ventilation, and lagging, which could lead to a complete revision of present concepts.

The second paper on 'Electric cookers for domestic purposes, with special reference to Maintenance costs', by J. N. Wailé, was based on the premise that the electric cooker appeared to offer the largest market for any individual piece of apparatus. Cooking was probably the most important section of the electrical service from a housewife's point of view. An early electric cooker can be seen in Fig. 37.

Referring to headquarter's matters, the Council of the Institution had recently discussed the question of closer co-ordination between the large engineering institutions, to which the other institutions had agreed. This co-operation was intended to apply not only to activities in London, but also between local centres and similar branches of the various institutions. The Mersey & North Wales (Liverpool) Centre had, of course, held joint meetings with other institutions and societies from its inception.

The current Faraday Lecture was again given in Liverpool. On this occasion the lecturer was Dr. A. P. M. Fleming, C.B.E., B.Sc., and the subject of the lecture was 'The evolution of electrical power'.

1938–39

Mr. E. L. Morland, of the Liverpool Corporation Electric Supply Department, was elected Chairman for the 1938–39 Session. His Chairman's Address entitled 'Unit building and its results' was

delivered in October 1938.[14] In his opening remarks the author stated that the domestic field was of primary importance because of the increase of unit output which could be brought about by the consumer who could adopt electrical methods in the home. Lighting and a radio receiver came first, but consumers could often be persuaded to use electrical energy for cooking, washing, water heating, and for other purposes. The average installation in an area in which 253 council houses had been built, totalled 18 kW per house, made up of a cooker, wash-boiler, two radiators, hot-water heater, iron and lighting. Building and industrial heating was another field of enterprise, but progress was slow. Railways required closer investigation, both from an economic point of view and to ensure a reduction in smoke and grime. The load required for streetlighting was continually increasing. Various items of domestic apparatus which have a historical interest are shown in Figs. 38–41.

In November 1938, Dr. W. G. Thompson, Ph.D., B.Sc., *(AM)*, read a paper entitled 'Recent progress in power rectifiers and their applications'.[15] The speaker gave a general survey of the present development of power rectifiers of the vacuum type (more strictly the low-pressure vapour type) which included hot-cathode rectifiers, air-cooled mercury-pool types, and nonvacuum types, e.g. mercury-jet apparatus, gas-cooled arc types, hydrionic convertors and mechanical rectifiers'. Dr. Thompson had come to the conclusion 'that the sustained importance of direct-current electrical engineering has been largely due to the progress of the rectifier' which had 'enabled the benefits of the flexible control of d.c. plant to be combined with the economics of a.c. distribution'. The rectifier had had far-reaching influence on transport, and the progress of main-line electrification and trolley-bus systems were significant in this respect. Rectifiers had been in course of development for more than a third of a century but finality had not been reached. Air-cooling would eventually be adopted and vacuum pumps would disappear.

Two papers concerned with television were read at a Centre meeting held in November 1938. The first was entitled 'The London television service' by T. C. Macnamara and D. C. Birkinshaw, M.A.[16] The authors described the television station recently built by the BBC at Alexandra Palace, London. They dealt specifically with early television and the 30-line experimental service, and the design, equipment and

performance of the new station. In a brief historical survey reference was made to Berzelios's discovery of the metal selenium in 1817, and May's discovery of its behaviour with varying amounts of light 56 years later. The invention of Nipkow's famous disc in 1884, and discoveries of Faraday in 1845, and those of Kerr in 1877, demonstrating the effect of magnetic and electrostatic fields on polarized light. The next step was A. A. Campbell Swintin's device described in *Nature* in 1908, which was a forerunner of the 'Emitron' in use at the London Television Station.

J. L. Baird carried out his experiments during the years 1923–1928 which ultimately resulted in a television system which gave reasonable results. Following arrangements made between the BBC and Baird Television Ltd. regular television broadcasts from the BBC's 2 kW transmitter in Oxford Street, London, commenced in 1929. Later in the same year they were transferred to the BBC's station at Brookman's Park incorporating the sound associated with the television programme, which started in April 1930. However, improved systems of television resulted in the 30-line transmissions being discontinued after the 11th September 1935.

The authors then discussed the important developments which followed. High-definition systems devised by Baird Television Ltd, and the Marconi–EMI Television Co. Ltd., were tried out. The first-named used 240 lines and 25 frames per second, whereas the second named employed 405 lines and 50 frames per second. The Alexandra Palace station was established and designed for the two systems. Experiments showed that the Marconi–EMI system was superior. In practice the use of two systems of definition introduced a number of disadvantages and, as a result, the Television Advisory Committee decided to adopt one standard only. In February 1937, it was publicly announced that transmissions from Alexandra Palace would be carried out on a single standard of definition, viz. 405 lines and 50 frames interlaced, giving 25 complete scans per second. Fig. 42 is reproduced from the paper.

The second paper referred to above described in detail 'the radiated waveform of the Marconi–EMI television system, and the electrical equipment supplied to the BBC in the London Television Station'.[17]

'Electricity in coal mines: a retrospect and a forecast' by R. Nelson, *(M)*, was the title of a paper read at a meeting of the Centre held in January 1939.[18] The author provided an interesting review of the use of electricity in coal mining from 1908 onwards, and included a statistical summary. He also gave an outline of possible future developments. Mr. Nelson informed his audience that electricity was first used for pumping in coal mining in 1883, when a small electrically driven pump was set to work below ground in the Forest of Dean. However, electricity had been used for lighting two years earlier at a colliery in Hamilton, Lanarkshire. By the end of the century, the use of electricity below ground had long ceased to be a novelty. Direct-current installations were more popular than those using 3-phase a.c. in 1908, the year that an Electrical Inspector of Mines was first appointed. In 1937 more than one million hp of motors was installed both above and below ground. Nevertheless, the miners were still distrustful and the 'task of alleviating the miners' mistrust rests more clearly upon him (the colliery electrical engineer) than upon any other colliery official'.

Finally, a paper entitled 'The trend of design of electric locomotives' by C. E. Fairburn, M.A. *(M)*, was delivered in January 1939.[19] The author based his theme on a survey of main-line locomotives of new design put into service during the last decade. Technical information had been obtained from ten railway companies in eight countries, and from 12 manufacturing concerns in five countries. It was clear that systems varied considerably in different countries. In particular the 3-phase system was making very little progress, and it was the author's view that it was unlikely to be extended.

During the session a suggestion had been made that an Education Section of the Institution should be set up to include in its scope all matters relating to the education of the whole of the personnel for the electrical engineering industry. The proposal was considered by the Council but the conclusion was reached that the subject of education did not lend itself to special treatment by one special section. Nevertheless, the Council did propose to set up an 'Education & Training Technical Committee' whose duty it would be to secure an adequate supply of papers on their relative subjects.[20]

The Faraday Lecture was again delivered in Liverpool. On this occasion the lecturer was Capt. P. S. Cohen, O.B.E., whose lecture was entitled 'The long distance telephone call – A Triumph of engineering and co-operation'.

CHAPTER 7

THE WAR PERIOD 1939–45

P. F. Rowell resigned the secretaryship of the Institution of Electrical Engineers in 1939, and W. K. Brasher, B.A., *(M)*, was appointed to succeed him. He took up his duties on the 1st September 1939 two days before the Second World War was declared.

Mr. Rowell was Secretary of the Institution from 1909–1939. He was born in London in 1874 and educated in Mauritius, and at King's College, London. He spent a few years with various engineering firms including the British Thomson-Houston Co. He then joined the Institution's staff as an assistant, when W. G. McMillan was Secretary. The latter was succeeded by G. C. Lloyd in 1904, and Mr. Rowell was appointed Assistant Secretary. When Mr. Lloyd resigned in 1909, Mr. Rowell was appointed Secretary. One of his first responsibilities was the completion of the purchase of the Institution building, and the transfer of the Offices from Victoria Street, Westminster. Mr. Rowell was Secretary when the Royal Charter was granted to the Institution in 1921. He proved an excellent administrator and possessed many attractive personal characteristics.[1]

Mr. Brasher, the new Secretary, was born in Bristol and educated at Clifton College. He graduated at St. John's College, Cambridge. Following a period of service in HM Forces during the First World War, he entered the Colonial Service and spent some years overseas. He then joined the Institution as its chief officer at a difficult time, but his unfailing interest and enthusiasm greatly helped to sustain and enhance the work of the Institution, both during the Second World War and the years that followed. He retired in 1962 after having seen the Institution grow considerably in strength of membership and prestige. He died on the 24th May 1972, aged 75 years.[2]

The events which led up to the Second World War culminated on the 1st September 1939, when Germany attacked Poland. On the 3rd September Britain and France declared war. On the 17th September, Russian troops marched on Poland from the east. The result was that, before the end of the month, Poland had been partitioned between the two invaders. Later the Russians fought the Finns and this conflict ended in March 1940, when large areas of Finnish territory were surrendered to Russia. Once the Polish invasion had been concluded there was a period known as 'the phoney war' which extended throughout the winter of 1939–40, when the fighting on land and in the air was negligible. This resulted in a lowering of morale and a belief in many people's minds that the war would soon be over.

The situation which developed following the declaration of war permitted Centre activities to continue, more or less normally, after the initial period of anxiety had been overcome. The Council of the Institution agreed that every effort should be made to carry on as many as possible of the activities normally undertaken. It was also decided that headquarters should continue to operate in London, and that library facilities would continue to be made available. However, it was agreed that the Faraday Lecture for 1939–40, by C. E. Fairburn, M.A., on 'Electric Traction', should not be given. In October 1939, Rollo Appleyard's 'History of the Institution of Electrical Engineers 1871–1931' was published by the Institution.

Before the war started arrangements had been made for a Central Register of National Service. It included machinery to determine priority of work according to its national importance. Persons already employed on work of national importance could remain in their posts, or they could be selected for work considered of greater national importance. Professional engineers were persons following reserved occupations. The result was that many members of the Mersey & North Wales (Liverpool) Centre, in common with other chartered engineers, continued in their normal employment. These regulations helped to avoid the manpower difficulties which had occurred during the First World War.

Prewar meetings were held in the Electrical Lecture Theatre at Liverpool University. Committee meetings were arranged to be held before the Ordinary General Meetings at the University Club, Mount

Pleasant, Liverpool, where members of the Committee always had a meal. J. Cormack has written:

> 'Timing frequently was cut rather fine and I recollect many occasions when Bill Parry had to round up sufficient taxis to get members up to the University. Arriving there we, complete with cigars, made an impressive entrance and filed into the front two rows of the Theatre. The straight-backed benches left something to be desired and various suggestions for improved comfort was reached by obtaining two long lengths of carpet runner which were duly spread out in the front benches at each meeting'.[3]

During the war and for many years afterwards Ordinary General Meetings were held at the Royal Institution, Colquitt Street, Liverpool.

1939–40

W. Holttum, M.Eng., of British Insulated Cables Ltd., was elected Chairman for the 1939–40 Session. He delivered his address entitled 'The mentality of the engineer' in October, 1939.[4] His remarks were concerned mainly with the actual, rather than the ideal. The mental quality of the engineer centred on mechanical ingenuity or constructiveness. He felt that the right approach to a problem was important and stressed the value of training. An engineer had to earn his living, but he also liked to think of himself as a benefactor to the community.

In December 1939, W. D. Horsley, *(M)*, of Messrs. C. A. Parsons & Co., Ltd., read his paper entitled 'Operating experience with high-voltage alternators'.[5] The author reviewed the experience gained with the use of high-voltage generators since the first high-voltage concentric-conductor alternator was commissioned in August 1928. That particular alternator had given 11 years of troublefree service. A further 20 alternators of the same type had been placed in service and an additional 13 were under construction. The original generator was a 33 kV concentric-conductor turbotype machine. It was put into commission in the Brimsdown power station of what was then the North Metropolitan Electric Supply Co. In general the operation and reliability of this form of generator had proved satisfactory. Basically, the concentric-conductor type of alternator incorporated the intersheath form of cable in its winding.

'Wire broadcasting investigations at audio and carrier frequencies' was the title of the paper read by Dr. T. Walmesley, B.Sc., at a Centre meeting held in January 1940.[6] The idea of conveying music and speech over a wire network was not new. It had been used by the Electrophone Co. in 1895, using the lines owned by the National Telephone Co. Radio broadcasting which 'seemed to seal the doom of wire broadcasting' was the cause of its rebirth. The author also gave some consideration to the utilisation of electricity supply for the distribution of programmes at carrier frequencies.

In March 1940, a paper entitled 'Oilless metalclad switchgear for medium-voltage alternating-current circuits up to 600 V, 3-phase' was presented by H. E. Cox, *(AM)*, and L. Drucquer, *(AM)*.[7] The authors reviewed the problems relating to medium-voltage switchgear and its applications. The construction and design of relevant air circuitbreakers and switch fuse gear was then described. They also dealt with h.r.c. fuses in so far as they affected the design of switchgear equipments and metal-enclosed switchboard units.

Glass insulators were discussed at a meeting held in March 1940, when a paper entitled 'The development of prestressed ('toughened') glass insulators' by P. M. Hogg, *(M)*, of Pilkington Brothers Ltd., was read.[8,9] The author briefly described the manufacture of glass and then discussed prestressed, or toughened, glass, which had 'been so treated after manufacture as to produce intentionally a strain distribution in which the surface layers are in a state of high compression'. There were thousands of toughened glass insulators in service at the time, but their life was unknown. The results of long-duration tests gave no indication of a limit.

The *Journal* of the Institution had been published in a single volume annually up to 1932. In 1933 it was issued in the form of two half-yearly volumes. Volume 88, which was published in 1941, was issued in three parts: Part I – General; Part II – Power Engineering; and Part III – Communication engineering. It continued in this form until it was superseded by the *Proceedings IEE* in 1949.

1940–41

In the second half of 1940, the Centre Committee decided that,

for the present the usual programme of meetings could not be held, owing to difficulties created by the war. One was the blackout at night, and another was the problem of travelling, due to restrictions and petrol rationing. Arrangements were made to hold two meetings on Saturday afternoons. One meeting was held in Liverpool and the other at Chester, at both of which J. E. Nelson delivered the Chairman's Address entitled 'The electric supply industry'.[10] Mr. Nelson, who was with the Mersey Power Co. Ltd., said that, although it started slowly electricity 'is (today) the servant of every household and of every factory'. The slow start was due mainly to 'legislative shackles which impeded their progress'.

Unfortunately, the attendance at the two meetings of the Senior Section held on Saturday afternoons was disappointing, and the Committee agreed that this did not offer a solution. It was then decided to defer any further meetings until they could be held on the usual Monday evenings. The first of these evening meetings took place on the 3rd March 1941, and the attendance was almost normal. On the other hand, the arrangements made later for the Students' Section to hold meetings on Saturday afternoons proved more successful .

At the meeting held on the 17th March 1941, G. F. Sinclair read a paper on 'The trolleybus'.[11] The author considered the construction of the double-decked trolleybus; the design of the electrical equipment, the chassis transmission gear, the method of current collection, and the overhead transmission system. The trolleybus was an electric vehicle, and its construction and operation were governed by Ministry of Transport regulations. In the UK, the author informed his audience, transmission was effected by a single-motor drive to the rear axle. The supply to the overhead system was 600 V, d.c. The trolleybus had good riding qualities and was noiseless in operation. It proved a very popular form of public transport vehicle at the time. The last trolleybus to run on the public service completed its journey at Bradford in March 1972, in the same city that introduced the original trolley in 1911.

In contrast to the Senior Section, the Students' Section experienced considerable difficulty throughout the session. Many of the members had joined the forces, or had been drafted elsewhere on government work. Only two meetings were held, one in October and one in March, both on Saturdays.

The annual golf competition held annually in aid of the Benevolent Fund was not practical, but a special appeal was made by the Chairman for the members to contribute financially to support the fund.

During 1941 the Council of the Institution 'appointed a Committee consisting of the President, the four immediate Past-Presidents, the Vice-Presidents and the Honorary Treasurer to study the problem of post-war planning in so far as matters appertaining to electrical engineering was concerned'. The Committee's terms of reference were as follows:

'To study post-war planning in electrical engineering with the object of making recommendations to the Council from time to time and in particular to consider and report on post-war developments in regard to:

1. Education, training and personnel
2. Fundamental and applied research
3. Electricity supply, distribution and installation
4. Production, manufacture and employment
5. Telecommunications, reconstruction and development;
6 The general policy of the Institution towards problems of post-war reconstruction and development, including any desirable changes in the structure and machinery of the Institution;
7 Problems of standardization of material and design. And to co-operate where desirable with other bodies and persons carrying out similar studies'.[12]

1941–42

E. G. Taylor's Chairman's Address was entitled 'Co-ordination as a means to standardization'.[13] He referred to the recently formed Post-War Planning Committee and the reference to its proposed study of standardization. He stressed the need for standardization to obtain the increased production necessary at the time. He reminded those present that the government had set up an Engineering Advisory Committee, under the chairmanship of Lord Hankey, with representatives from the Institutions of Civil, Mechanical and Electrical Engineers, and Government research and production departments, to advise the Government on engineering questions connected with the war effort. Mr. Taylor

then discussed various aspects of standardization in electrical engineering and suggested that it had 'lagged too far behind technical progress to maintain a healthy condition in the industry, the development of the heavier engineering commodities having continued, for the most part, on individual lines'.

As a result of the Institution's interest in post-war planning, the Centre Committee invited members to send short contributions to the Honorary Secretary of the Centre regarding problems of postwar reconstruction. The contributions would be classified and summarized under the seven headings into which the Council had divided the subject. An informal discussion would be arranged to discuss the contributions.

In the second half of the session the Centre was presented with a paper by Dr. W. G. Radley and E. P. G. Wright entitled 'Voice-frequency signalling and dialling in long-distance telephony'.[14] The authors reminded their audience that 'between the two great European wars telephone systems of the majority of cities and large towns of the world have been converted from manual to automatic operation'. At the same time notable improvements had been made to the long-distance telephone service. One of these was the introduction of the use of voice-frequency currents for signalling and dialling. They went on to describe the problems encountered in designing the system and how interference between signals and other currents in the voice-frequency range were avoided. Future lines of development were necessary to keep pace with changes in automatic switching and speed transmission.

In London, on the 19th February 1942, a paper entitled 'The electric spark in air' by J. M. Meek, D.Eng., *(AM)*, was read before the Institution. In 1946 Dr. Meek would be appointed to a Chair at Liverpool, and, in due course President of the Institution.

In Liverpool, on the 16th March, a conference was held on 'Intensive training' with representatives of the Institution of Mechanical Engineers at the request of Lord Hankey's Technical Personnel Committee, presided over by the Lord Mayor of Liverpool. Senior members of staff of the large engineering firms and technical colleges attended.

The Annual General Meeting was held on the 20th April 1942, and following the completion of the business, a number of 10-minute papers was read, based on selected contributions received on 'Postwar

planning'. This method was adopted in preference to reading the summaries of sectional reports as originally envisaged.

Two additional meetings were held in May. The second meeting was arranged to consider the report entitled 'A critical review of education and training for engineers' prepared by the Education & Training and Personnel Sub-Committee of the Institution's Postwar Planning Committee, and presented to the Mersey and North Wales (Liverpool) Centre by Prof. Willis Jackson, a member of the Sub-Committee.[15] There was a large attendance and an interesting and prolonged discussion. The visitors included Sir Noel Ashbridge, President of the Institution, and W. K. Brasher, the recently appointed Secretary made his first visit to the Centre.

1942–43

The programme arranged for the 1942–43 Session consisted of meetings held in the early evening during October, the first week in November, and the months of February, March and April. Owing to the blackout and transport restrictions, no meetings of the Centre were arranged during the darker parts of the winter months. The Students' Section continued to meet on Saturday afternoons.

The Chairman for the new session was H. Pryce-Jones, whose Chairman's Address was entitled 'Some observations on water-tube boiler Practice'.[16] The author contended that electrical equipment used for power plant at that time appeared to have reached its limit of reliability and efficiency. Steam pressures had increased over the past 25 years from 350 lb/in^2 to 1000 lb/in^2 and over, but general current commercial practice inclined to main stop-valve pressures of 600–650 lb/in^2. Many features relating to existing boiler practice were discussed. In the author's opinion boiler availability was of more urgency than boiler efficiency, or rather a small increase in boiler efficiency.

Included in a report of the Centre's activities published in the *Journal*[17] at this time was a note regarding the difficulties of the Students' Section. They arose from the frequent changes in membership due to students at local colleges and the university moving from the district to obtain works training, or to promotion involving changes of residence. Although these difficulties were common in Students' Sections

throughout the country, the Liverpool Students' Section was fortunate in having retained the support of a number of members, including some who had occupied the chair.

During 1943 the *Journal* printed the title of the Centre minus the word '(Liverpool)' and this brought a strong protest from the Centre Committee, and the Secretary of the Institution reinstated the name of the town. The question of including the name of a town in the title of a Centre had been discussed by the Council, but no decision had been made. Having established its case, the Committee then agreed to the deletion of the word '(Liverpool)' in the title of the Centre, and this change became effective in 1944.[18]

1943–44

The new Chairman was Mr. T. E. Houghton, M.Eng., who chose 'Industrial power supply' as the subject of his Chairman's Address.[19] In his paper the author considered industries in which (a) the cost of electricity was a small fraction of the cost of the final product; (b) the provision of both process steam and electricity were essential; and (c) the need arose for large supplies of electricity at high annual load factors, and in which the cost of power was a large, if not the major portion of the total production cost. Following a detailed survey, Mr. Houghton argued that there was not an overwhelming case for transferring all industrial supplies of electricity to the public systems. On the contrary, there were sound reasons in favour of private generation in special circumstances, e.g. where large supplies at high load factors were concerned.

At another meeting E. L. Dewey, B.Sc., assisted by Mr. Pirrie, read a paper by himself and C. J. Beaver, on 'The high-pressure gas-filled cable'.[20] After briefly reviewing the position regarding existing types of high-voltage cables the authors gave the reasons underlying the development of the gas-filled cable. The conclusion was reached that this form of cable system possessed certain advantages and, because its technical and economic positions were sound, it should be given full consideration when schemes involving power transmission at voltages of 33 kV and upwards were envisaged.

On the 21st February 1944, Sir A. Stanley Angwin, D.S.O., M.C.,

T.D., B.Sc.(Eng), President of the Institution, accompanied by the Secretary W. K. Brasher, paid an official visit to the Centre. After the usual courtesies on such an occasion, J. Kemp presented his paper on 'Waveguides in electrical communications'.[21] The attendance was 150 members and visitors, which created a record for an Ordinary Meeting of the Centre up to that time.

The author provided a survey of the state of published knowledge of a branch of engineering which had recently become prominent, and what was in effect a new technique. He showed that the subject had its origin in the researches undertaken by Lord Rayleigh and other workers at the end of the 19th century. The development of the theory and its practical application, however, had been carried out mainly in the USA. He provided a systematic account of the development of elementary equipment appropriate to hollow-tube transmission, and described phenomena observed at the open ends of guides—both flared and unflared—and considered the efficiency of these devices as radiators of energy into free space. It was pointed out that the field of application embraced

> ' . . . systems of communication operating over any distance, and providing telephone and television channels in numbers vastly exceeding those of any system of established type. When flared into horns, guides may serve in systems for broadcasting music or television, for blind landing of aeroplanes; for detecting, locating and manoeuvring of ships; and for other purposes for which at present radiators and receivers of conventional type are used'.

Mr. Kemp said that considerable attention had been given to the subject since 1936. Published communications had dealt with two classes of guides. The first were in the form of dielectric cylinders surrounded by air. They were designated 'dielectric guides', and were 'capable of propagating electromagnetic waves through their interiors or of radiating them into space'. But the chance of their practical application appeared to be remote. The second class consisted of metal tubes fitted with a dielectric, and were 'capable of propagating electromagnetic waves through their interiors or of radiating them into space through openings in the tube walls'. They had been designated 'conducting guides' and were the subject of the paper. The author conjectured that, in the future, the field of application would be large and attractive.

In June 1944, the Council of the Institution adopted the recommendation of the Wireless Section Committee that the name of the Section should be changed to 'Radio Section', and that its scope should be extended to include electronics.

1944–45

The new Chairman J. Cormack, B.Sc., Principal of Bootle Municipal Technical College, delivered his address entitled 'Some thoughts on education' in October 1944.[22] It is pertinent to recall that Mr. Cormack spent 19 years on the Committee of the Mersey and North Wales Centre, and served as a Member of Council *(ex officio)* during the periods 1944–45 and 1945–46. He wrote:

> 'This was a hectic two years—leaving Liverpool in an air raid to arrive in London during another—having done three return journeys in one week, being asked by the sleeping-car attendant if I was doing it for enjoyment—sitting in committee listening to the crunch of bombs. I was actually in London when the last V2 came over'.[23]

He was one of the honorary auditors for 11 years, and one of the senior representatives on the Graduate & Students' Section for many years until 1969. He was also a member of the Centre's Education and Training Circle from 1961–65.

In his address, Mr. Cormack reviewed the various Education Acts from 1870 onwards and, in particular, discussed the provisions of the new 1944 Act. He felt that insufficient consideration had been given to the experience gained in the part-time day-class scheme, which had developed over the past century, and which had its origin in the 'works schools', established by employers in their own premises. He quoted the example of the Admiralty in founding the Dockyard Schools in 1843. Mr. Cormack acknowledged that higher education had received very adequate treatment in recent reports and discussions. He mentioned one matter concerning the universities to which the report called attention, namely the necessity of 'training all university lecturers in the art of teaching'. He suggested that the importance of this requirement must be evident to those who had been connected with the universities, either as students or as members of staff.

A further problem was the status of major technical colleges, and

another concerned the respective roles to be taken by the universities and the colleges. Some current solutions were mentioned, e.g. it was suggested that a new National Diploma scheme should be set up, with a wider scope than the existing one, controlled by 'a highly influential and widely representative council', which could lead to the status of the Diploma being 'recognised as the full equivalent of a university degree'. However, more than 20 years were to elapse before solutions began to be found to these problems.

The Centre lost one of its keenest supporters when P. J. Robinson, C.B.E., M.Eng., died on the 23rd November, 1944, only a few months after his retirement from the post of City Electrical Engineer of Liverpool. He became Deputy City Electrical Engineer under Harold Dickenson, whom he succeeded as City Electrical & Lighting Engineer in 1928. He became responsible for the design and construction of the Clarence Dock power station, and also acted in a consultative capacity in connexion with the construction of the first Mersey road tunnel. Mr. Robinson was the Centre Chairman in 1926–27. He was awarded the C.B.E., in 1943 for the valuable services rendered to the electrical industry. The writer of the obituary notice in the Institution's *Journal* recorded that ' "P. J." was a notable figure of outstanding presence and had a dynamic and tireless personality, but at the same time he was a very human companion'.[24]

In March 1945, a paper entitled 'The Development of polythene as a high-frequency dielectric', by Prof. Willis Jackson, D.Sc., D.Phil., *(M)*, and J. S. A. Forsyth, B.Sc., was read, which dealt mainly 'with the power factor of polythene (the high polymer of ethylene) which, being normally of the order of 0·00015–0·0003 renders the material highly suitable as a high-frequency dielectric'.[25] Some account was given of the difficulties encountered in the production of the material and the discovery of an antioxidant which made its use possible.

The joint meeting with the North-Western Centre and the Chester Engineering Society, held at Chester in March 1945, when a paper entitled 'The electrical aspect of farm mechanization', by C. A. Cameron Brown, B.Sc., proved of outstanding interest. Officials of the National Farmers' Union, and farmers with practical experience in the application of electricity to farming, took part. The attendance was 150. Members and visitors were welcomed by the Mayor of Chester at the Town Hall, where the meeting was held.