

## CO-OPERATIVE RESEARCH IN THE ELECTRICAL INDUSTRY OF GREAT BRITAIN

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**B**OTH the manufacturing and the electricity supply sides of the electrical industry in Britain were highly organised and practising co-operation long before the incorporation of the British Electrical and Allied Industries Research Association. The Institution of Electrical Engineers began co-operative research in 1913. The manufacturers started shortly afterwards. These activities were merged in the 'Electrical Research Committee' in 1917, which adopted the organisation of a research association in 1920 and thus has just passed its jubilee.

The Electrical Research Association is, however, peculiar in that it has never been the principal organ of research in the industry, which covers a very wide field of diverse activities; the larger manufacturers in the several sections possessed specialized laboratories prior to its formation. To-day, 90 per cent of the research work done by the industry is carried out in such laboratories. On the other hand, the electricity supply section has limited facilities for research outside the Association; only a few of the larger undertakings, such as the Central Electricity Board, have any such facilities. The technical problems of that section are, nearly all, common to the whole section and appropriate for treatment by the Electrical Research Association.

The electricity supply industry in Britain is still the largest user of electrical plant and apparatus, but the manufacturers are in turn large users of other manufacturers' products, and it is this user interest that most readily lends itself to co-operative research. Prior to the formation of the Electrical Research Association, there was practically no research conducted in the user interest save where a user conducted his own research; this led to overlapping and some confusion. Immediately, however, such work was put on a co-operative basis, manufacturers were able not only to share the cost but also to obtain great benefit from closer technical co-operation both with their customers and with their competitors in problems of common interest. Indeed, to-day it is well known that the solution of some of these problems, so secured, has given a return showing gains greatly exceeding the Association's total expenditure from its inception to the present day. Incidentally, the larger part of these gains has been passed on to the public, who are able to obtain a cheaper and more reliable supply of electrical energy and many novel electrical appliances.

The efficiency of steam plant can be greatly improved by raising working temperatures; but to realize this involves steels for boiler construction and turbines, etc., able to withstand high working stresses for many years although red hot, also an accurate knowledge of the properties of steam at those temperatures. The electrical industry stood to gain so much from any such advance that, possessing the necessary co-operative facilities, it organised and financed the large-scale and long-time work required, and made a present of the results to all users of boilers and steam plant.

It is probably in the field of dielectrics that the Electrical Research Association made its most important initial contribution to the unspectacular improvement of technique and standardization. One

experienced manufacturer said recently that "The user nowadays is apt to take for granted the excellence and suitability of materials now available, whereas a glance backwards by the older members of the profession will undoubtedly remind them of the terrible 'try and try again' methods which were involved in any new design. Nowadays the designer knows exactly what to expect and is morally certain that if he specifies it he will get it. All this he owes very largely to co-operative research."

Research on materials, if it is to have practical value, requires the co-operation of craftsmen and technicians; but it has also afforded the Electrical Research Association its best opportunity for demonstrating the necessity of enlisting the help of workers in fundamental science. Fortunately most of the problems fall under the head of the 'theory of the solid state', one of the live issues in scientific research and involving in practice as well as principle all material properties. Research of a high order has been done by members of the staff, but emphasis should be placed on the assistance obtained from many leading figures in the world of pure science. To mention only a few heads of research institutes or departments under whom the Association's programmes have been carried out, we have the following physicists and chemists: Sir Lawrence Bragg, (the late) Prof. H. L. Callendar, Dr. C. H. Desch, Sir Alfred Egerton, (the late) Sir John Fox, Prof. N. F. Mott, Prof. W. Sucksmith and Prof. A. M. Tyndall. Of particular interest is the value derived from theoretical physicists working independently in those fields where lack of basic principles was retarding progress, and it is pleasing to note the growing realization that theoretical physics is as necessary in industrial applications as is experimental science. The importance of mathematics in industrial problems where text-book simplifications rarely apply led to the strengthening of the Association's resources in this respect, when the need was still inadequately recognized by most practising engineers. In all these efforts it has been a source of great encouragement to note the readiness with which leaders in other fields are willing to co-operate as soon as they find that the work is being done for the common good.

Researches on the phenomena of circuit breaking and on surge phenomena have resulted in revolutionary ideas, based upon scientific theory. In both fields it is probably true to say that the electrical industry has not yet felt the full impact. In the field of circuit breaking, however, the advances made are so varied as to parallel almost all those made in other industrial countries. The majority of heavy-power circuit breakers manufactured in Great Britain in recent years have been made under licences from the Association, and are unequalled for reliability of performance. The results of nine years work on surge phenomena, conducted on an adequate scale under the stimulus of financial support from the Central Electricity Board, have recently been published in book form, and establish not only a reliable basis for technical practice and plant design but also important progress in the problem of the lightning flash and in more recondite cosmic phenomena.

The extension of the amenities of a supply of electricity to rural areas presented many new problems and afforded an ideal field for co-ordination of considerable but unrelated effort. Before the War, investigations leading to simplification and standardization of practice in distribution were well advanced, and the best methods of applying electrical power to many activities in farming and horticulture were under investigation. The needs of the war and post-war periods emphasize the value of this contribution to food production.

It is impossible to touch upon many fields of work in which there has been good progress; but mention may be made of an investigation of fire-fighting methods adapted for safe use with electrical plant, which was completed in time to be of great service during the unforeseen effects of modern war. A topical feature is the Association's incursion into the field of domestic space- and water-heating, which well repays the scientific approach.

The research atmosphere in committees provides neutral ground for the free discussion of technical difficulties, but neutrality is apt to disappear when the investigator discovers an error in established practice. The demonstration that one or two spectacular tests of a large circuit breaker proved nothing as to its proper commercial rating was vigorously rejected at first, but eventually led to a great increase in testing facilities and corresponding improvements in the product. Great savings in expenditure on electric cables, the result of research, did not commend the Association in some quarters, but eventually assisted the rapid expansion of manufacture and use by the resulting reduction in the cost of electrical distribution. The regulation of voltage was regarded as the proper business of the station engineer, until it was found that a scientific study of the problem shed useful light both on the economic and technical aspects in relation to the advantages of a reasonably constant voltage for electrical appliances. There was recently some fear, now largely resolved, of the possibilities of a scientific analysis of matters which might throw light on the formulation of economically sound tariffs. The Electrical Research Association was discouraged initially from publishing its discovery that oil gas could be replaced by air in circuit breakers, save as a laboratory experiment, and it has taken about twenty years for the industry to absorb the resultant inventions.

The Electrical Research Committee had no laboratory or research staff. Its business was to organise co-operation between all branches of the industry and to plan and place out research work. The British Electrical and Allied Industries Research Association, to give the Association its full title, in continuation of this policy, at first placed out all its researches with member concerns, the National Physical Laboratory, the universities, technical colleges and individual experts. Soon, however, facilities were required which could not be found in this way; for example, access to large generators, traction batteries, overhead lines and other plant under working conditions. Thus, while still avoiding unnecessary duplication, the Association found it necessary to obtain a staff of its own and to provide temporary accommodation for personnel and apparatus. In this way there was accumulated a quantity of specialized equipment adapted for field investigations; for example, a multi-element oscillograph with high-speed camera and contactor gear housed in a trailer. A good example of co-operation occurred when a trans-

portable high-voltage oscillograph and generating gear was required for studies of surge phenomena: the several interested manufacturers pooled all their ideas and information so as to secure the best possible instrument in the common interest, and then submitted competitive quotations for its manufacture.

After about twelve years, it was found economical to establish a single centre as headquarters for the Association's field work and accommodation for the Association's experimental research staff. This 'auxiliary laboratory' was put in hand at Alperton, to be opened by H.R.H. the late Duke of Kent in 1935. Meanwhile the Association continued to increase its operations in a geometric progression until the quantity of research placed out was proving an embarrassment to those asked to assist. Thus it was found necessary to extend the laboratory and the staff, so that at the beginning of the War the larger part of the Association's work was being carried out by its own staff.

During the War, thanks to the support of the Department of Scientific and Industrial Research, the Association, by then fully established as an essential part of the electrical industry of Britain, was able to continue its services to industry in the national interest as an 'essential undertaking'. At the same time its unique facilities and liaison with industry was gradually recognized by the Services and Supply Departments, so that about one third of the work at the Laboratory was carried out under direct contract with them. Several members of the staff were lent to the Service Departments, under conditions that enabled them to keep contact with the Association and utilize its facilities. Much of the work done is of interest solely to those directly concerned, but mention may be made of contributions to communication interference suppression, mine- and bomb-location, radio components, degaussing, opencast coal prospecting, and finally the design of the electrical equipment of tanks, which eventually came largely under the control of the Association's staff. Two inter-Service and manufacturers committees were organised by the Association, one on capacitors and the other on automobile ignition systems. The proportion of new projects to reach some degree of successful operation may be claimed to have been exceptionally high. This work came under the supervision of Dr. S. Whitehead, who, at the turn of the Association's twenty-fifth year, succeeded the present writer as the second director of research.

Apart from a discontinuity in the first three war years, the Association's income has been an exponential function of its age, roughly doubling every eight years or so; it started at about £15,000 in 1920 and was approaching £150,000 in 1945. About 80 per cent both of the manufacturing and supply sides of the industry, based on wages and revenue respectively, support the Association, which enjoys also a very gratifying number of members in the British Commonwealth overseas, together with a substantial membership in allied industries. During the War the Alperton site of 1½ acres became clearly inadequate to cope with essential post-war developments or indeed with the accumulation of deferred work, so a site of 48 acres has been purchased at Leatherhead. Here, in company with certain other research associations, it is hoped to set up an establishment appropriate to a growing industry, the needs of which outstrip the trained personnel available and to which the pooling and planning of research will become of ever-increasing importance.