Industrial Research Associations.

I.—BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION.

By J. W. WILLIAMSON.

THE British Scientific Instrument Research Association is one of the earliest research associations formed under the scheme of the Committee of Privy Council for the promotion of scientific and industrial research. It was founded, as is stated in the third annual report of that Committee, "through the efforts of the optical industry, guided by the whole-hearted energy and zeal of Mr. Conrad Beck, the president of the British Optical Instrument Manufacturers' Association." The association was incorporated on May 30, 1918, and established on lines broad enough to include all scientific instrument makers. In November, 1918, a group of firms representative of the electrical scientific instrument, electro-medical, and X-ray industries joined the association, which may now claim to be what the above-named report of the Committee of Privy Council stated in August, 1918, it had every prospect of becoming—the representative industrial body dealing with the application of science to the manufacture of scientific instruments. The association was fortunate in securing from the outset as its director of research Sir Herbert Jackson, K.B.E., formerly Daniell professor of chemistry at King's College. Mr. J. W. Williamson was appointed secretary of the association, and, later, Mr. H. Moore assistant director of research, with special reference to the electrical and X-ray researches of the association.

The first task of the newly formed association was to secure suitable premises for offices and research laboratories, and in November, 1918, the remaining term of the lease of 26 Russell Square, W.C.1, was purchased, and the association entered into possession on Armistice Day, November 11, 1918. Steps were immediately taken to effect the necessary structural alterations and to equip the premises with laboratories and secretarial offices, and now, on the completion of its first two years of life, though more remains to be done, the association has a relatively well-equipped research institute, with a scientific staff of six research workers, all university graduates experienced in research, in addition to the director of research and the assistant director of research.

In the beginning the association suffered a grievous loss by the untimely death, in August, 1918, of its first chairman, Mr. A. S. Esslemont, on whose wisdom, zeal, and powers of organisation the members had confidently counted to guide the association in its early career. He was succeeded in the chairmanship by Sir Arthur Colefax, K.B.E., who rendered valuable service to the association, and when, owing to the pressure of other duties, he was compelled to resign the chair some months ago the association was fortunate in securing as chairman Mr. A. A. Campbell Swinton, whose high scientific attainments and wide experience will be of great benefit to the association.

The council of the association consists of fifteen elected members, five co-opted members, and five members appointed by the Department of Scientific and Industrial Research. The addition to the elected members of council of these Department representatives and co-opted members has been of great service to the association in enabling the council to view from a wide angle and to a far horizon the varied problems presented to it, without impairing the predominant interest of the members representing the industry or modifying the necessary bias of the association's activities towards practical results.

The main and immediate functions of the association, the council has agreed, are:—

(a) To prosecute research into the questions of pure and applied science arising out of the urgent needs of the scientific instrument industry.

(b) To take long views and to investigate those questions, whether of pure or applied science, upon which the future of the industry may be conceived largely to depend.

(c) To investigate systematically and continuously the field of application of scientific instruments.

Time and experience will show whether and how far these guiding principles need to be modified or amplified.

Just as the actor's art, however subtle, will fail if it does not get over the footlights, so will these associations for scientific and industrial research fail in one of their primary functions if they do not get the results of their researches over into the workshops of the industries. Two years is all too short a time for any association to accomplish much in this way. The first year is necessarily spent mainly in organisation and preliminary surveys of work under contemplation. But the British Scientific Instrument Research Association has, nevertheless, obtained results of research of immediate utility which have already found practical application in the workshops, and are of considerable benefit to the industry.

For example, as the result of an extensive research on polishing powders, a rouge was prepared for the hand and machine polishing of lenses, prisms, etc., which, tested by optical firms, has proved to be thoroughly successful in the workshop. It has been manufactured on an industrial scale, and is now standardised and in regular use by optical firms. This research has given rise to much investigation on the purely scientific side, and to further work of an applied nature with the view of decreasing substantially the time of polishing glass and similar materials. The comprehensive researches of Sir George Beilby on this subject, especially in connection with the flow of solids under mechanical disturbance, has been of great value.

Another line of investigation which has been occupying the association from the start is on

abrasives. Much work has already been done both from the purely scientific point of view and on the production of abrasive powders. Materials made in the laboratory are being tested in workshops, and it is hoped soon to publish reports on the whole investigation and on the practical results.

Again, in response to a need expressed by the industry a solder was prepared in the association's laboratories, capable of being used for all the ordinary metals, including aluminium, and of withstanding a temperature of approximately 350°C. , so that it could be used when the later heating of joints made by it was necessary—*e.g.* in enamelling. This also has been manufactured on a large scale, and industrial firms are engaged on extended tests of it. The reports to hand are very promising. Another solder, fusing at a low temperature, for special use with aluminium, has also been made on the laboratory scale, as the outcome of the previous research, and is now being tested by certain firms.

The association has also been able to give immediate assistance in the matter of securing suitable and trustworthy liquids for level bubbles, and is now engaged on problems connected with standardising the glass for the bubbles and with methods of preparing the inside surface. In this connection it has been considered important that purely scientific research on the fundamental physical problems connected with this investigation should be prosecuted so that not only may the practice in manufacturing level bubbles be improved, but also the reasons underlying it may be fully elucidated. This is being done for the association, extramurally, in one of the London technical colleges.

An interesting investigation, apparently dealing only with a small detail brought to the attention of the association, led to a considerable amount of research work on the cause of the tarnishing which had been found with certain tissue papers used for wrapping up polished glass. A report on the whole research has been issued to members, and so far as the practical issue is concerned the position is apparently quite clear as to the properties which the paper must have and the method of testing whether it has them. Here, again, the research has given rise to problems which are of great interest in connection with physical and chemical questions about colloids, and would be suitable for further investigation on academic lines. It is under consideration what arrangements can be made for this work to be done elsewhere in some university or technical college.

Another research of immediate practical importance to the optical industry is the research on cements for prisms and lenses. A report on this subject has been issued to members, and in the important matter of obtaining cements which have no tendency to change either in the direction of crystallisation or in the gradual deposition of insoluble matter, and do not tend to break away from the glass surface, very considerable progress has been made. This investigation on

cements has led to a large amount of relevant work in the matter of insulators, a subject of importance to the electrical members of the association, and is an example of the advantage of the wider outlook which is obtained in an association such as this where the needs of one of its departments are co-ordinated with those of another. There are, of course, many scientific problems raised here which might well prompt pure science research—*e.g.* into the causes and conditions of crystallisation or of other instability in resinous and similar substances.

Questions on the purity of chemical compounds and on the relation of purity to stability are raised by the research being undertaken by the association to study the durability of different types and meltings of optical glass under a variety of conditions. Similarly, another research of the association into the question of the production of a glass of truly neutral tint raises fundamental questions of the theory of colour in glass.

It is impossible in a short article to do more than take almost at random a few examples of the researches being undertaken by the association, but enough has been said, perhaps, to show that, even in those researches being prosecuted for immediate practical ends, fresh problems in pure science are raised, or wider vistas opened out, which may well be suggestive and stimulating to the workers in the laboratories of purely scientific institutions.

The programme of research of the association is, naturally, rather the private affair of the association, but it may be said that it ranges from problems in pure science involving the fundamentals of optical, electrical, or chemical theory to technological investigations on the methods and materials of manufacture, including, for example, such a practical problem as the best lacquer for making an instrument look well finished.

It may be well to point out that, besides the specific researches included in the programme of research, the association in its character as the scientific centre of the industry is called upon from time to time to assist the industry by contributing from a scientific point of view suggestions and criticisms to the appropriate Government and other quarters on such matters as the supplies of raw materials and the manufacture in this country of products essential to the development of the British scientific instrument industry. Much work in this direction has already been done. Moreover, users of scientific instruments have already brought to the notice of the association, and, as the association becomes better known, will doubtless tend increasingly to bring to its notice, their specific needs. In this way the association will perform a useful scientific *liaison* office between the users and the manufacturers. Already, by means of conferences and otherwise, the association has enabled the manufacturing members to become better acquainted with the scientific needs of the users, and the users to appreciate the limitations imposed on the manufacturers by design, material, or other conditions.

In the task of industrial reconstruction after a devastating war which the British scientific instrument industry, in common with other British industries, has now to face and accomplish, its most potent means must be the extension of scientific research to the varied problems of the industry. In this work the co-operative research of the association and the particular research of the individual firms are essential and complementary. The work of the association does not supersede, but emphasises the need for, and assists, the scientific research undertaken by individual firms. In the same way, the pure science research of the universities and kindred institutions is essential and complementary to all re-

search carried out by the research associations or by industrial firms. The universities and their like are the great sources of purely scientific research, and to them we look for that fundamental work which, probably in many cases not of immediate applicability to industry, is bound to be the foundation of future guiding principles. Nowhere is this more fully recognised than in the British Scientific Instrument Research Association. Its work is also largely purely scientific, but to fulfil its purpose of immediate utility to its relevant industries it necessarily cannot always follow through to completion the numerous lines of investigation which arise out of the problems studied.

Microseisms.

By J. J. SHAW.

HOW often we use the term "terra firma"! It is used despite the fact that no square yard of the earth's surface is ever at rest; an unending train of waves, waxing and waning in amplitude, are unceasingly coursing along the earth's crust and to unknown depths. The wave period ranges between 4 and 8 secs.; the amplitude is between $1/50,000$ and $1/2000$ in., but with a wave-length of 8 to 16 miles. The speed of the waves is believed to be about 2 miles per sec. These microseisms have been known to seismologists for twenty years or more, and were originally thought to be air tremors. Later, the rocking of the observatory buildings in the wind was suggested as their origin, or the rocking of the ground due to the motion of trees in the vicinity; but it is now established that these disturbances are pure earth-movements travelling over long distances. With sensitive seismographs, microseisms are easily recorded, but whilst hypotheses have not been lacking, their origin and cause still remain unknown.

Prof. John Milne, in 1898, suggested ("Seismology," p. 285) that the cause may be twofold: (1) air currents and convection currents within the instrument cases; (2) a ground movement produced by rapid changes of barometric load. Before that time, Bertelli and Rossi had noted the connection of microseisms with barometric change.

In America, Burbank observed an increase in amplitude when a barometric load passed from land to sea, or *vice versa*. At the International Seismological Congress held in Manchester in 1911 funds were provided for the investigation of microseisms, and Prof. O. Hecker, of Strasbourg, was deputed to undertake the work.

Daily comparisons were made between the microseisms recorded and the state of the sea at Cape Grisnez, Heligoland, and Borkum, a connection between sea waves and these movements having long been suggested. The war intervened, and the conclusions do not appear to have been published.

In earthquake investigation observers are by NO. 2663, VOL. 106]

this time fairly familiar with the easily recognisable chief phases, viz. "primary" and "secondary" waves, followed by "long waves" which rise to a "maximum"; hence it is comparatively simple to trace any particular phase around the globe, and by this means to determine the respective rates of propagation and to compile seismological tables for future guidance.

Microseisms do not lend themselves so readily to this kind of treatment. Fig. 1 illustrates a section of a record when microseisms are pronounced, and shows how similar one train of waves is to the next, thus defying identification of any particular wave at distant stations.

In May, 1917, the present writer was testing two similar seismographs in different buildings 60 ft. apart. The machines were arranged on the same electrical time circuit, and both oriented in the same azimuth. It was observed how closely similar were the microseisms on both records, showing that the air tremor hypothesis was untenable. A seismograph has two kinds of sensitivity—one to tilt, in which the period of the pendulum plays the more important part; the other to a horizontal thrust, where the ratio of the leverage, operating about the "steady-point," is the chief factor. These seismographs were constructed with the same sensitivity to horizontal thrusts, but, as an experiment, the period of one pendulum was raised until the sensitivity to tilt was four times that of the other. Under these conditions the recorded amplitude of the microseisms was approximately the same, whereas the large waves of an earthquake which were recorded were from three to seven times greater on the machine more sensitive to tilt. This seems to suggest that microseisms are principally a horizontal motion; but against this must be noted that seismographs designed for vertical motion record microseisms quite freely.

The fact that microseisms could be identified on instruments 60 ft. apart pointed to the advisability of attacking these waves on entirely new lines, viz. gradually to extend the distance between the observing stations so long as the identification of