One of the most interesting pre-breakdown phenomena in liquids is that of light emission at high fields. Gosling has examined the electro-luminescence of carefully purified fractions of mineral oils at high fields, and finds that both light output and conduction current vary in a manner similar to that found in solid phosphors. The position and brightness of the light emitted depends on the gas content of the oil, its chemical constitution, and the degree of electrode oxidation. Darveniza was among the first to observe light emission from liquids at high fields; recent work of his was reported, in which he investigated the phenomena in both liquids and in solid dielectrics doped with fluorescent solutes (these include anthracene and *p*-terphenyl).

The electric strength of liquids, measured with short rectangular pulses, can be changed appreciably by the application of a static stress to the system before the pulses are applied. Ward described measurements of this type in hexane; it was suggested that a static stress sets up charge layers on the electrodes and that these layers modify the emission from the cathode and hence change the pulse strength of the liquid. Gallagher has made breakdown measurements in liquid argon using direct and impulse voltages, applied to uniform and non-uniform gaps. The effect of gaseous impurities was investigated and small quantities of dissolved oxygen were found to increase the strength. It was noted that the breakdown strength depends also on the condition of both cathode and anode.

A thermal mechanism of liquid breakdown was described by Watson and Sharbaugh, based on their conduction current measurements under microsecond pulse conditions. It was suggested that local currents are large enough to be space charge limited, and the energy input needed to cause breakdown is that required to vaporize the liquid. Krasucki has shown that in viscous liquids the first stage of breakdown involves the formation of a region of low density, which has a lower breakdown strength than the surrounding medium. He suggested that this also occurs in non-viscous liquids, and a model was set up for the formation of the bubble involving the hydrodynamic equations of liquid motion adjacent to the cathode. It appears likely that under many conditions the breakdown of liquids involves a thermal process, and the formation of a vaporized region; it is therefore important to know the breakdown strength of liquid and vapour at high temperatures and pressures. Sharbaugh and Watson described measurements of the electric strength of hexane vapour and liquid. No discontinuity in strength was found in going through from vapour to liquid, in the critical region.

A number of conclusions regarding conduction processes in liquids can be drawn from the work presented at the conference. From measurements of charge carrier mobility, it is clear that, in insulating liquids in general, the conduction process is an ionic rather than an electronic process, and that except in the liquefied rare gases free

electrons do not normally exist in insulating liquids. An electron would be expected to have a mobility of $1 \text{ cm}^2/\text{V sec}$ or greater; for lower mobilities one can no longer talk of free electrons—though hybrid species may exist, such as thermally excited electrons, moving from trap to trap (the so-called 'hopping' electron). The low order of magnitude of carrier mobilities measured in organic liquids implies either an ionic carrier, or a hopping electron; moreover, the variation of the mobility with viscosity seems to follow a Stoke's law type of relationship (though the agreement is not perfect) so that an ionic species seems to be the most likely form of charge carrier. At very high fields the situation is less clear, and the fact that light emission has been observed from insulating liquids containing fluorescent additives, at fields approaching 10^6 V/cm , has been taken as evidence for the presence of energetic electrons in the liquid; other mechanisms of excitation are possible, however, so that even this evidence is not unequivocally in favour of a free electron.

There are a number of speculations as to the nature of the trapping site for electrons in liquids; hydrocarbons such as hexane, for example, do not trap electrons in the vapour phase, yet they seem to contain highly efficient electron traps in the liquid phase. It is possible that the traps are associated with the local degree of disorder of the liquid; the resulting traps must be deep ones, however, for a shallow square well (of the type required by the hopping electron model) does not predict the correct field dependence of mobility. The polaron model may be appropriate, particularly for highly polar materials. The mechanism whereby charge carriers are generated is beginning to look more complicated than had been suspected; until recently one had tended to assume that the charge transfer process, taking place at the interface between electrode and liquid, was similar to that between metal and vacuum, but recent results, implying photo-generation of carriers at both anode and cathode, must make us revise many of these views.

Turning finally to high-field conduction and electrical breakdown in liquids, the question of the relative importance of electronic processes in this region still remains; there is virtually no evidence for collision ionization in recently published work, though it was almost taken for granted a few years ago. Indeed, it is becoming increasingly evident that under the experimental conditions in use at present—even in the use of microsecond pulse techniques—electrical breakdown of liquids is probably not an electronic process in the generally accepted sense, but can often be explained in terms of thermal effects.

It has been impossible, in this report, to mention all 43 papers which were presented at this conference: for a complete list of these papers and authors, the reader is referred to a companion review by M. J. Morant, which is to appear in the *British Journal of Applied Physics*.

P. K. WATSON

INSTRUMENT DESIGN: MANUFACTURE AND USE

THE new headquarters of S.I.M.A., the Scientific Instrument Manufacturers' Association of Great Britain Ltd., at 20 Peel Street, London, W.8, were officially opened on January 14. The president, Mr. R. E. Burnett (Marconi Instruments Ltd.), in welcoming the guests referred to 1962 as a particularly busy year for the Association in which a number of significant developments in external relations occurred. The association was invited to co-operate with the National Economic Development Office in its initial examinations of certain sectors of industry, and a survey was made by the Association, based on available published statistics and certain

forecasts provided by the industry, of the growth potential of the instrument industry. The exercise disclosed the unsatisfactory nature of the official information, particularly in regard to the classification of products and to industrial employment.

Mr. Burnett emphasized the importance of closer collaboration with instrument manufacturers overseas and reported that during 1962 S.I.M.A. became associated with the Comité Européen de l'Optique et de la Précision de Mécanique. The Comité is an informal organization of parallel trade associations of the Common Market countries and is concerned with the exchange of information,

particularly statistical information, and with the discussion of trade problems of mutual interest. Contact was also made with the Instrument Society of America and the Scientific Apparatus Manufacturers' Association of the United States of America.

In co-operation with the Board of Trade and the Central Office of Information, groups of members of S.I.M.A. took part in six exhibitions in Budapest, Sydney, Helsinki, Vienna, New York and Milan. Individual reports on these exhibitions are given in the January issue of *SIMA Review* (3, No. 1; 1963). A special effort was made during 1962 to expand the sales of instruments in Italy and to stimulate the interest of members of Italian universities, technical colleges and research establishments in British instruments.

Output and exports of instruments were again above the record level of 1961. The latest figures, up to November 1962, showed that exports were running at the rate of about 13 per cent greater than those for the similar period during 1961 and that they were expected to reach about 54 million pounds for the full year, representing a rise of 100 per cent since 1958. Particularly good progress was made by the Optical Instrument Section of the industry. Between 1958 and 1961 production of optical instruments rose by 33 per cent and exports during the past three years totalled some 30 per cent of the production, with the United States and Australia as the main markets.

Following a talk given by K. E. Morgan of the Department of Agriculture, University of Reading, at a meeting of the Electronics Section and Nucleonic Group of S.I.M.A., a number of firms interested in the promotion of the use of measurement and instrumentation in agriculture were formed into a new specialized group, the Agricultural Instrument Group, of S.I.M.A. Contact has been made with the Agricultural Research Council and with other Government bodies. In order to collaborate and maintain contact with the various organizations and projects for the development of new syllabuses for the teaching of physics and related equipment, a steering committee has been appointed by the Educational Instrument Group. Dr. D. S. Beard (Griffin and George Ltd.) is honorary secretary of both the Agricultural Instrument and the Educational Instrument Groups.

The eleventh annual convention of S.I.M.A. was held at Eastbourne during November 7-9, 1962. The theme was "Looking Ahead—The Next Five Years". The opening address was delivered by the president. Mr. R. Brech (Unilever Ltd.) spoke on "The Economic Outlook in the U.K. for the next five years", and divided his talk into an impressionist picture in which the opportunities which exist were outlined and a realistic picture in which the extent to which the opportunities could be seized and used effectively were described. He concluded by stating that the coming five years would be tougher than the previous five years, but that with confidence, marketing skills, good designs and good management Britain would be able to hold its own. Mr. M. Seaman (College of Advanced Technology, Loughborough) discussed education and training in his address on "Future Trends in Engineering and Production", and described some highly sophisticated developments in shipbuilding and their place in the shape of things to come. Following these two sessions the delegates split into three discussion groups to consider the implications of the talks from the points of view of administration and training, technology, and marketing. It was agreed that there was a tendency among many foreigners to regard the British as old-fashioned and stodgy, but it was felt that the 'British image' was not wholly bad, since it had a reputation for quality and integrity. There was a great need for a substantial increase in the availability of information about the reliability of components of all types, and attention was directed to the British Scientific Instrument Research Association survey on "Literature

on Reliability". General concern was expressed at the form of education in secondary modern schools, where those who stayed for the further two years did not benefit from the extension. It was considered that the standard of teaching in schools needed improvement and that the teachers should be more alive to the needs of industry.

Three other addresses were given to the convention. Mr. E. G. C. Burt (Royal Aircraft Establishment, Farnborough) gave a review of instrumentation in space research, describing in particular the *Aerial* satellites, the astronomical telescope satellite, and communications satellites. "Science and Everyday Life" was the title of Dr. G. Margerison's talk in which he surveyed some of the new fields in which instruments had started to be applied. He emphasized that great scope for improvement existed in the fields of agriculture, biology, transport and communications. Finally, Dr. E. Eastwood (English Electric Group) gave an instructive and entertaining evening discourse, illustrated by slides and film, on "Radar Observations on Bird Migration". A report of the convention is given in the January issue of the *Review* and a summary of the addresses and discussions forms an insert to the number.

The education and training of personnel for the instrument industry is of especial interest to S.I.M.A., and recently Mr. C. W. Robson, formerly vice-principal and head of the department of electrical engineering and applied physics at South-East London Technical College, was appointed educational adviser to the Association. He has since visited a number of member companies in connexion with their apprentice training schemes. The course on "Leadership in Instrument Design", which was inaugurated by a joint committee of the British Scientific Instrument Research Association and S.I.M.A. and planned by the Northampton College of Advanced Technology to commence in October 1962, attracted only two students. The course had failed because it was too long and necessitated the absence of senior technical personnel from their firms for a period of some twelve months.

The provision of a text-book on instrument design for student use has been met by the publication of *A Guide to Instrument Design**, sponsored by the British Scientific Instrument Research Association and S.I.M.A. The book, which has just been published, consists of a group of nine chapters, on varied topics and written by different authors, but which together form a pattern. The preferred method, sometimes called the project method, of carrying out the development of an instrument through its various stages from the initial idea to design studies, prototypes, costing and final production is the subject of Chapter 1, by Dr. J. Thomson (British Scientific Instrument Research Association). In Chapter 2, Prof. H. F. Trewman describes the fundamental limitations in instrument design. The theory of errors, kinematic design, transducers, noise, masers, computers and ergonomics are all, strange to say, dealt with in this chapter and it is difficult to see the connexion that Prof. Trewman wishes to make between them. However, an attempt is made towards the end of the chapter to emphasize the general principles by brief considerations of a few individual instruments. Mechanical design, the subject of Chapter 3 by G. Birkbeck (Mullard Research Laboratories), will appeal to engineers, as also Chapters 5 and 6, where electronic instrument design and nucleonic instrument technology are treated. These two chapters are remarkable for the almost complete absence of circuitry and for the amount of valuable information, largely omitted from the usual text-books, which they contain. Dr. W. T. Welford (Imperial College of Science and Technology, London) is well known as an able teacher

* *A Guide to Instrument Design*. Produced by the Scientific Instrument Manufacturers' Association of Great Britain (SIMA) and the British Scientific Instrument Research Association (BSIRA). Edited by the Staff of BSIRA. Pp. xii+444. (London: Taylor and Francis, Ltd., 1963.) 63s. net.

and writer on optics, and Chapter 4, which he contributes, is an outstandingly lucid and comprehensive manual on optical design. Within 130 pages, he clearly distinguishes between the three different types of optical instrument and lists their design parameters, and then describes in detail how the parameters may be determined for particular optical systems and how systems with given parameters may be designed from available light sources, optical materials and detectors. The chapter concludes with an extensive list of references to which the interested student may refer for additional study.

Two important but somewhat neglected topics are considered in Chapters 7 and 8. These are the reliability of instruments and intrinsic safety. Finally, since an instrument is a piece of equipment to be used, the concluding remarks in the brief six pages of Chapter 9 on integrated design are valuable because they serve to remind the designer that instruments should be such as the user will like to handle and which will give him the

information he requires in the most easily assimilated manner.

The Association continues to receive a large number of enquiries from home and overseas, and the Enquiry Service has been dealing with an average of 400-450 a month. A new leaflet directing attention to the service is being prepared for distribution to members. The card index system used to answer enquiries has been brought up to date. The Publicity Committee has been concerned with the improvement of Press relations for the greater dissemination of information about the instrument industry, and arrangements have been made in conjunction with the Central Office of Information to commission a series of articles on new developments and applications in instrumentation. The articles will be offered in the language of the country to technical journals overseas and also to selected journals in the United Kingdom. Mrs. H. Conway was appointed Press relations officer in July 1962.

S. WEINTROUB

THE NEW YORK ACADEMY OF SCIENCES

THE 145th annual meeting of the New York Academy of Sciences was held on December 5, 1962, at 2 East 63 Street, New York. During the year ending October 31, 1962, considerable progress was made in the recovery of the Academy's financial status, both for improvement of its operating budget and for strengthening its investments. The increase in income permitted an extension of the budget for conference and publication costs, an increase from thirty-nine to fifty in the staff, and the establishment of a medical care and group life insurance scheme for the staff. The financial statements, together with the reports of the Chairman of the Board of Trustees, the Treasurer and the Recording Secretary, are published in the January issue of the *Transactions* of the Academy (25, 265; 1963).

The Sciences, the new publication of the Academy, which was established in 1961, has been brought up to date on its publishing schedule. Thirty-one issues of the booklet, totalling 496 pages, were published during the year under review. In the *Annals* thirty-eight monographs, comprising 6,206 pages, and containing 501 papers by 796 authors, were published. As from January 1963, the publication date of any conference monograph will be within fourteen weeks subsequent to a conference, provided the authors submit their manuscripts within two weeks of the conference. Beginning with Volume 25, the *Transactions* will also follow this schedule. The demand for conferences to be held by the Academy continues to grow and the number of papers independently presented for publication in the *Annals* is also increasing regularly each year. Consequently, the Scientific Council has decided that with the current year, 1963, members of the Academy may select up to twenty

separate monographs listed each year, with the added privilege of purchase of any publications of the Academy at a 20 per cent discount.

During the year, eighty-five meetings were held by the various sections and divisions of the Academy. The section of Biological and Medical Sciences held a joint meeting during January 1962 with the Columbia University seminar on "Genetics and Evolution" and a joint symposium with the division of Microbiology during April. The division of Instrumentation held a series of eight symposia on "Electronics in the Medical Specialties", and the papers in this series will be published shortly as a monograph. Details of the twenty-two conferences held between November 1961 and October 1962 are listed in the annual report.

The membership had a net increase of 622 during the year, with a record total of 16,249 members in October 1962. A maximum of fifty candidates may now be nominated each year to the fellowship of the Academy. The following were elected officers for 1963: C. H. Mushett, president, Rev. J. J. Lynch, president-elect, and K. Maramorosch and C. C. Stock, vice-presidents of the Scientific Council; C. R. Noback, recording secretary, and R. F. Nigrelli, corresponding secretary.

The Academy consists of the sections of biological and medical sciences, chemical sciences, physical sciences, and planetary sciences, and the divisions of anthropology, instrumentation, microbiology, psychology, biochemistry, biophysics, engineering and mathematics. The sections and divisions meet regularly, one evening a month, during the academic year, October-May, inclusive, in the Academy's premises in New York. The conferences are held at irregular intervals.

UNIVERSITY EDUCATION IN INDIA

THE fourth annual Conference of Vice-Chancellors of the Indian universities and institutions 'deemed as universities' was held at New Delhi during October 11-13, 1962. The report of this Conference* includes the inaugural address of Dr. K. L. Shrimali, Minister of Education, Dr. D. S. Kothari's address on some aspects of university education, the address of the Prime Minister, Sri Jawaharlal Nehru, and the recommendations of the

three Committees dealing with admissions, medium of instruction and related matters; service conditions of college and university teachers, and three-year degree courses; and contents of education and co-ordination of research. The most important feature of Dr. Shrimali's address is the stress laid on the medium of instruction. While any university or college will be completely free to continue to use English as a medium of instruction if it wishes, and use of English has been recommended as an alternative or associated medium by the National Integration Council, Dr. Shrimali is firmly convinced that unless

* India. University Grants Commission and Ministry of Education Vice-Chancellors' Conference, 1962. Pp. v+81. (New Delhi: University Grants Commission and Ministry of Education, 1963.) Rs. 2.00; 4s. 8d.; 0.72 dollars.