such a maximum can also be derived from measurements of specific heat. In the discussion, Dr. M. Blackman stated that on theoretical grounds this maximum is very difficult to explain.

In a paper on measurement of lattice parameters and thermal expansion at low temperatures, Prof. G. O. Jones (Queen Mary College, London) described work done in collaboration with B. S. Figgins and D. P. Riley. The apparatus was designed so that only the specimen was at the low temperature, and an accuracy of 1 in 10^5 in the measurement of the lattice parameter could be achieved. The temperature could be kept constant to 0·05 deg. at the lowest temperatures. So far, measurements of the lattice parameter (and hence of the thermal expansion) of aluminium have been carried out between 20° and 125° K. The results confirm earlier work of Bijl and Pullan, that at low temperatures there is a considerable deviation from Grüneisen's law. Measurements on solid argon are also in progress. In connexion with this work, Dr. E. R. Dobbs (Queen Mary College, London) gave a short contribution in which he described a simple back-reflexion camera for experiments on solidified gases down to 77° K. This has been used for work on solid krypton.

Mme. L. Couture (Centre National de la Recherche Scientifique, Bellevue) described work, done in collaboration with P. Jacquinot and I. Tsujikawa, on optical observations of transition in crystalline hydrates at low temperatures. The experiments showed that the absorption spectra of some substances (in particular, certain of the alums) changed at low temperatures, and these results were compared with corresponding changes which had been found in measurements of paramagnetic resonance. Complete agreement between paramagnetic and optical results was not achieved, but nevertheless the optical experiments confirmed that changes in crystalline structure do occur at low temperatures, especially in some of the chromium alums.

The conference showed that, while a large amount of X-ray work is already being done at temperatures down to 77° K., using liquid nitrogen as the coolant, not very many experiments have been done at lower temperatures, using liquid hydrogen or liquid helium as the coolant. There is still a very wide field of research open to anyone who has the necessary cryogenic facilities. In addition to the lectures already described, an evening discourse, entitled "Molecular Crystals", was given by Prof. J. D. Bernal (Birkbeck College, London).

In a meeting of the X-Ray Analysis Group which preceded the joint conference, a discussion was held on the collection and classification of crystallographic data for determinative and reference purposes. The discussion was opened with contributions by Dr. J. W. Hughes (University College, Cardiff) on the A.S.T.M. index, Prof. E. G. Cox (University of Leeds) on the single-crystal index, Dr. M. H. Hey (British Museum) on the Barker index of crystals, and Dr. L. E. Sutton (University of Oxford) on a bond-length index. Dr. W. B. Pearson (Ottawa) gave details of the index of metals and alloys which should soon be available. Several speakers in this discussion emphasized the need for research workers to send in their crystallographic and X-ray data to the compilers of the various indexes. Many of the data are obtained as an incidental part of some other research, and very often they are not published. Hence, they are overlooked when reference books are being written.

A full account of the conference will be given in the *British Journal of Applied Physics*. The next conference of the X-Ray Analysis Group will be held in London during November 16–17; two sessions will be devoted to biological structures, and one session to computational methods.

H. M. Rosenberg

DIGITAL COMPUTER TECHNIQUES

A CONVENTION on "Digital Computer Techniques" was held in London at the Institution of Electrical Engineers during April 9–14, at which more than fourteen hundred persons attended, including 127 delegates from overseas countries. These figures emphasize the rapid growth of interest in this field, since at a similar convention, held three years ago, only two hundred in all were present. On the evening of April 9, after the convention had been opened by the president of the Institution, Sir George Nelson, an inaugural address was given by the president of the Royal Society, Sir Cyril Hinshelwood, and this was followed by an introductory lecture by Prof. F. C. Williams. During the next three days, fifty-eight papers were read. The papers had been divided into two groups: those of general interest, and those of interest to specialists. Normally, a general and a specialist session were held simultaneously, so that in this way both the non-expert and specialist were satisfactorily accommodated. On the last two days of the convention, visits to typical computer installations were made. These visits had been arranged with the co-operation of commercial companies, government establishments and universities; nearly nine hundred delegates availed themselves of these opportunities.

In his address, Sir Cyril Hinshelwood referred to the diverse lines of thought which have been successfully combined in the computing machine of to-day. Essential contributions have come from the theory of numbers, the relations between mathematics and logic, the discovery of various electric and magnetic phenomena, and the invention of the thermionic valve. He emphasized that the philosophy, in this case of machine design, preceded the actual construction and thus was not an afterthought about results, as it sometimes is. Having introduced the computing machine in this way, he then turned to view and speculate upon the interesting and exciting panorama which is beginning to unfold before us. On the scientific side there is now the prospect of solution of hitherto intractable problems; in the business world the mechanization of all kinds of clerical work and accountancy can be contemplated; and in industry the process of automatic control can be improved and carried a further step towards the final goal of complete 'automation'. The use of machines in this way must effect a displacement of man-power, and could amount to another industrial revolution. Sir Cyril Hinshelwood expressed the hope that any necessary redistribution of labour would be carried out without any serious results from the human and economic points of view. Finally, after a brief excursion into the seemingly age-old problems of 'Can machines think?' and the 'machine–brain analogy', he concluded by expressing his admiration of this work and his great confidence in its future.

In his lecture, Prof. Williams indicated the rapid development in the field of digital computers by con-

sidering the history of a typical computer installation, namely, that at the University of Manchester. Parallel developments have occurred elsewhere, but he selected this installation because of his familiarity with it. During the period 1946–56, two large-scale machines and one experimental transistor machine have been constructed. A commercial version of the first large-scale machine has been in continuous operation since 1951 and has now completed some 17,500 hours of useful computation. During this period, thirty-four different groups of users drawn from other universities, government establishments and industrial firms have operated the machine. Furthermore, 104 people have been trained to use the machine, and sixty-six scientific papers have been published using machine results. A commercial version of the second large-scale machine will be in operation at the University near the end of this year.

Prof. Williams went on to say that machines are attractive for many reasons: first, they can be universal so that they are capable of solving a large variety of problems; secondly, they are automatic, so that only a small amount of human intervention is needed; and finally, they are very fast, so that computation times are cut and, what is more important, many calculations previously impossible now become feasible. Machines are also relatively error-free; at the present time, on an average the machine makes one mistake in 4 million operations. What human being could compare! Moreover, though the hire of a machine appears expensive, in terms of cost per operation a machine is fifty times cheaper than a human computer would be. This latter comparison is only applicable if the machine is fully employed.

Looking a short distance into the future, Prof. Williams forecast machines which would be simpler to use, smaller in size, more economical in terms of power consumption, and also more reliable. However, the major steps, he stated, would be in the realization of the potentialities of these machines, and so a rapid expansion in the application of machines would result to the ultimate benefit of all. He concluded his lecture with the following remarks: "If at this juncture we are swollen headed with the sense of our achievements, or alternatively despair of further improvements, we have only to consider, for example, a rose seed. This very small particle contains all the data necessary for the manufacture of an unending and ever increasing supply of roses".

All the sessions on April 10 were of a mathematical nature and thus more of interest to the machine user. The topics of discussion in the specialist sessions were numerical analysis and logical design, five papers being presented. Computer applications were discussed in the general sessions, these being divided up into three sections: engineering and scientific calculation; business applications; and industrial control. Many papers were presented, the variety in the subject-matter illustrating immediately the universal nature of these machines. Topics ranged from testing the design of a proton synchrotron, to payroll calculations and the exploration of functional relationships in industrial processes. The main item of discussion during the day was a vital one, namely, that of machine reliability. Dr. I. J. Faulkner placed this particular problem in its right perspective, when he stated that progress towards a machine possessing a reliability of 100 per cent is very desirable, but no piece of equipment, whether electronic or not, yet possesses this feature. Further, until absolute perfection is guaranteed, systems dependent on a machine will have to be designed to 'fail safe'. In the light of these remarks, machines at the present time are adequately reliable for a great deal of progress to be made. Indeed, if the argument of waiting for more reliable machines were adopted, nothing would be achieved for a very long time.

The general sessions on April 11 were devoted to machines existing or in the process of construction in Great Britain. Two large-scale computing machines are now commercially available. One is the 'Deuce', which possesses a high-speed store of approximately 12,000 binary digits located in mercury delay-lines. A magnetic drum-type store of capacity 260,000 digits is also provided which has electronic selection of a block of sixteen heads. Further blocks of these heads are selected by means of a novel mechanical system. Input and output facilities are provided by means of punched cards. In the second machine, 'Mercury' magnetic core storage is used, and this high-speed memory contains 40,000 binary digits. Further storage of 650,000 binary digits is divided over four magnetic drums. Selection of the heads on these drums is entirely electronic. An interesting feature of this machine is its power to carry out 'floating point' arithmetic in a completely automatic manner. Input and output facilities are at the present time by way of teletype tape. In addition to these two machines, numerous smaller-scale models are being constructed.

The two specialist sessions, one on rapid access storage and the other on magnetic tape systems, also aroused great interest. At the first session Mr. N. H. Taylor, of the Massachusetts Institute of Technology, reviewed the history of the magnetic core store and gave an account of its present development in the United States. The climax was reached when he stated that a two-million digit store is well under construction at the Institute. In Britain the cost of the cores alone would be £80,000, which is greater than the complete cost of either of the machines already mentioned.

In the second session, two papers devoted to the development of tape systems moving the tape at speeds of the order of 100 in./sec. and with digit packing densities of approximately 100 digits/in. were presented. The tape is capable of moving in either direction and can accelerate up to full speed in the order of 15 m.sec. A further paper in this session discussed the design and operation of a head which is capable of reading digits off a tape even when this tape is stationary. At the present state of development, the head can identify digits with a packing density of 50 digits/in. The discussion revealed that many people realize the potentialities of this type of head.

At the first general session on the last day the design and construction of two point-contact transistor machines, one at Harwell and the other at the University of Manchester, were discussed. These operate at digit frequencies of about 100 kc./s. It is apparent that transistor development in Britain lags far behind that in the United States, since the latter already have transistor prototype machines functioning at a digit frequency of 5 Mc./s. At a subsequent specialist session, a lively debate took place on two papers utilizing techniques based on the combination of magnetic cores and junction transistors.

Other sessions on analogue/digital conversion and circuit techniques and components were held, but

the main interest was aroused in a session discussing the computer in a non-arithmetic role. Here papers were presented on language translation, the playing of games and, finally, character recognition. A contribution was made by the U.S.S.R. delegates, who have been carrying out English to Russian translation on one of their machines since early in 1955. They assured their audience that the result was good Russian.

In conclusion, it can be stated that the convention brought together a large amount of detailed and expert technical knowledge in the various aspects of digital computers and their use. There is no doubt, too, that it proved valuable in some way to all who attended. The complete proceedings of the convention, containing the addresses, lectures, full text of all papers, and reports on the discussions, will be published in three issues as a supplement to Part *B* of the *Proceedings of the Institution of Electrical Engineers*.

DAVID B. G. EDWARDS

BRITISH AGRICULTURAL HISTORY SOCIETY

ANNUAL MEETING

SINCE it was founded in 1953, the British Agricultural History Society has held its annual meeting near Easter, and this year's meeting was at the Florence Nightingale Hall, University of Nottingham, on April 13. Officially, the annual general meeting is confined to one day—a business meeting in the morning followed by one or more papers read by members, and either more papers in the afternoon, or a visit to some point of interest. In addition, however, an after-dinner lecture was given in the evening of the previous day by Mr. John W. J. Higgs, curator of the Museum of Rural Life, Reading, and also honorary secretary of the Society. His lecture, which dealt with the problems involved in the identification and preservation of agricultural exhibits, was pleasantly informal and illustrated with lantern-slides. From the pictures it was clear that it is often difficult to discern the use of an object sent in, and even more so to date it. One such question arose out of the discovery on English farms of numbers of ox-shoes, or cues. It seems quite unlikely that bullocks on a farm would ever be shod, even if they were used for draught purposes, though they might be if used on roads. The explanation is probably that the animals were shoed before being brought from distant breeding-areas—Wales and Scotland, for example—and that it was not worth taking off any that remained on after the journey; eventually the shoes wore off and were dropped on the farm where the beasts were grazed. Many other similarly perplexing questions arise.

After the business meeting on April 13, the rest of the morning was occupied by two lectures, the first of which, given by Malcolm Gray, lecturer in economics in the University College of North Wales, Bangor, was on the "Consolidation of the Crofting System, 1750–1850". The story is extremely complex. Until 1815, population increased in the Western Highlands and Islands, and the number of crofts went up. Many were quite minute, only an acre or two. Attempts were made to meet the demand for land by rearranging the holdings, a kind of enclosure, but very different from the work done under Enclosure Acts in England. The kelp industry and the linen industry did a good deal to ease conditions, and the introduction of the potato was a boon. It provided more food from a given area than a grain crop. But it was attacked by disease, and the kelp industry lost ground in face of the competition of imported potash. These two factors, and a number of others, helped to make it difficult for the crofting system to survive. Dr. W. G. Hoskins, reader in economic history in the University of Oxford, gave the second lecture, which was on "Sheep Farming in Saxon England". There is only limited and scattered evidence on which to base such a lecture. A little is supplied by archæology, some by the study of place names, and some by a few documents. From these sources Dr. Hoskins has deduced the distribution of sheep in Anglo-Saxon England, and has estimated the total number as being about six million, or three or four sheep to each human being.

In the afternoon a visit was paid to the open fields at Laxton, now owned and preserved by the Government. Dr. J. D. Chambers, of the University of Nottingham, who is well known for his studies of the eighteenth century, acted as guide, and Mr. Rose, bailiff of the Manor, showed the fields.

THE PLACE OF UNIVERSITIES IN AUSTRALIA

THE Australian Vice-Chancellors' Committee has published in pamphlet form a symposium of papers on "The Place of the Australian University in the Community and Post-Graduate Studies in the Australian Universities", which were delivered during August 11–12, 1955, at a Commonwealth Inter-University Conference arranged in Australia by the Association of Universities of the British Commonwealth and the Australian Vice-Chancellors' Committee*. The first of these papers, by Prof. P. H. Partridge, on the Australian universities and Governments, gives a clear account of the closer dependence of Australian universities upon the State and Federal Governments, and this paper will assist those in Britain to understand some of the difficulties and dangers to which the Australian universities are exposed and also some episodes that may have puzzled those reading about them. Moreover, some of these dangers, such as that arising from the tendency in the thinking of Governments to subordinate research, advanced scholarship and post-graduate studies to the more elementary functions of making it possible for large numbers to gain degrees, could arise in Britain in appropriate circumstances; and Prof. Partridge notes other factors, such as the absence of any considerable proportion of university-educated men among Australian politicians, which have contributed to lack of understanding of the universities or respect for their autonomy in Australia. While he thinks the existing structure may be unhealthy and dangerous, he does not think that the independence of the Australian universities has been affected as much as might have been expected.

* Australian Vice-Chancellors' Committee. A Symposium on the Place of the Australian University in the Community and Post-Graduate Studies in the Australian Universities. Pp. 66. (Canberra: Australian Vice-Chancellors' Committee, c/o Australian National Committee. London: Association of Universities of the British Commonwealth, n.d.)