programming. He felt programming could be left to the less able. His final appeal was to the grammar school master to encourage their best boys and girls to take up engineering as being a useful job in which they would find a lot of pleasure.

Dr. Crank, a physicist by training and in industry, and latterly a mathematician by adoption, referred to the report issued by the Organization for Economic Co-operation and Development and spoke of the difference in character and thinking between the mathematician and the scientist (and engineer). This difference is something which, all too often, both sides fail to appreciate. He stressed the need for postgraduate specialist courses such as are already provided in many colleges of advanced technology. Only thus can an overcrowding of the undergraduate syllabus be avoided. While he did not consider any great changes in school courses to be necessary, other than a knowledge of modern mathematics, he felt, as did Prof. Bickley, that undergraduate courses should place much more emphasis on formulation and less on solving. His ideal syllabus would be that given in the report issued by the Organization for Economic Co-operation and Development, but he would vary the amount of mathematics as between the theoretical and practical physicist. He regarded the computer as having tremendous motivating power for the student; and spoke of the need for the engineer to acquire the same facility with the computer as he would expect to have with the lathe. This imposes on the lecturer a need to teach mathematical techniques appropriate to the computer's finite steps.

In the subsequent discussion Mr. F. W. Kellaway and Mr. A. W. Geary spoke of the need to motivate the pupils at school to work and to think, and to leave the colleges to teach the user mathematics. Mr. Kellaway regarded the Newsom Report as being as important as the Robbins Report and directed attention to the importance of proper training of the fifteen-year-old apprentice. As a principal of a regional college of technology he deplored the teaching of 'calculations' by engineers and made a strong appeal for the establishment of separate departments of mathematics in all colleges of technology. Mr. Geary and others spoke of the need for co-ordination between departments.

The Geometry Dilemma

Dr. J. E. Wallington led the third discussion of the conference on the "Geometry Dilemma". He felt that the present tendency to replace analysis and geometry by analysis and algebra was representative of a sickness in our approach to geometry, but he saw no evidence that geometry as a subject would be allowed to die. While the modern mathematician must divorce himself from physical experience he saw no reason to ignore it. The greatest mathematicians would admit their use of diagrams, and modern algebra was full of geometrical names and ideas to designate its properties and processes. In criticizing the old geometry syllabuses, he outlined the University of Hull syllabus which he suggested brought out both the beauty and the significance of geometry in modern mathematics.

Dr. Wallington appealed for the early introduction of co-ordinate geometry in schools, and for the teaching of two- and three-dimensional geometry in parallel. In his view, students were entering universities or going into the world with less logical ability than of yore, and he questioned the value of set theory in acquiring this ability.

The discussion from the floor represented the confusion which exists in most teachers' minds as to how one can reconcile teaching logic with geometry, when the only logical way seemed to be to start at the middle, work on establishing the standard results, and then work back and establish the premises. Nevertheless, all speakers felt that geometry had a place in school and university syllabuses, as suggested by Dr. Wallington. Some initiative in setting new style examination papers for the General Certificate of Education would seem to be required.

In summarizing, Dr. Wallington felt that the discussion had shown that Euclid, instead of being found at fault, had proved himself to be too good for the age group for which we tend to use him. Unfortunately we had found nothing to replace him for this age group.

General Lectures

Dr. R. C. H. Tanner, speaking on "Mathematics begins with an Inequality", showed how inequality, having been an integral part of the algebra courses up to about sixty years ago, seemed to disappear from the algebra syllabus with the First World War only to return quite recently. The reason was not clear.

Mr. G. Smithers gave his most constructive ideas on a new single applied mathematics paper at Advanced Level to include statistics and probability, circuits, differential equations, linear programming, games, vector algebra and rigid and particle dynamics and thus develop mathematical aptitude.

In the final lecture, Dr. J. C. Polkinghorne, with the disarming title of "Mathematics of Elementary Particles", in one lively hour developed elementary particle physics from the quantum theory through the S.U. theory to the recent apparent verification of that theory.

Elections

At the annual general meeting, Dr. I. W. Busbridge was elected president for 1964–65. The following officers were re-elected: *Honorary Treasurer*, Mr. R. E. Green; *Honorary Secretaries*, Mr. F. W. Kellaway and Miss R. K. Tobias; *Editor*, Dr. E. A. Maxwell; *Librarian*, Prof. R. L. Goodstein; *Honorary Assistant Secretaries*, Messrs. K. J. Backhouse, B. J. F. Dorrington, Miss E. M. Holman, Dr. E. Kerr and Mr. C. Steele; *Honorary Assistant Treasurer*, Mr. N. Q. Dodds. The work and influence of the Association continue to grow and, with the need for proper public relations, Instructor Captain R. G. Cross, R.N. (Retd.), was elected to the list of assistant secretaries to meet the requirement.

R. G. Cross

THE FEDERATION OF EUROPEAN BIOCHEMICAL SOCIETIES

FOLLOWING a decision taken at Oxford on July 18, 1963, the Federation of European Biochemical Societies came into being on January 1, 1964. Its first meeting, organized by the Biochemical Society for the Federation, was held during March 23–25 at University College, London, and was attended by more than 1,000 biochemists. The nineteen European biochemical societies which have so far joined the Federation are those of Austria, Belgium, Bulgaria, Czechoslovakia, Denmark, Finland, France, East Germany, West Germany, Great Britain, Hungary, Italy, The Netherlands, Norway, Poland, Portugal, Spain, Sweden and Switzerland. Individual biochemists from the U.S.A. and U.S.S.R. were also present, but the East German delegates were unable to obtain visas to attend the meeting. The participants were welcomed by the first chairman of the

Federation, Prof. F. C. Happold (Great Britain). In addition, all overseas biochemists were invited to a reception given by the Minister for Science.

The central feature of the meeting was a one-day symposium, arranged by Dr. F. Sanger (Cambridge), on "The Structure and Activity of Enzymes". Present-day interest in the study of biological activity at the molecular level was reflected in the fact that three of the four sessions were devoted to ribonuclease, chymotrypsin and hæmoglobin, proteins which have been intensively studied from this point of view in the past few years. The primary structures of all three are now known. The amino-acid sequence of ribonuclease has been known for some time and that of hæmoglobin has recently been elucidated, while the complete primary sequence for chymotrypsin was given at the symposium by Dr. B. S. Hartley (Cambridge) and Dr. B. Keil (Prague). While these findings and similar work on trypsin are of fundamental importance, the nature and spatial relationships of the residues in the active regions are being actively pursued. This was evidenced by the presentation of papers on the active sites of ribonuclease, certain esterases, carbonic anhydrase and chymotrypsin, and on conformational investigations using both purely chemical techniques with chymotrypsin and X-ray analysis with ribonuclease, hæmoglobin, chymotrypsin and chymotrypsinogen. Notable among these was a paper by Dr. M. F. Perutz (Cambridge), who discussed the change in the position of the β-chain sub-units within the molecule of hæmoglobin during oxygenation. The problem of the dissociation of hæmoglobin was taken up by a number of speakers, and it is apparent that most of the phenomena involved can be explained if hæmoglobin is thought of as an equilibrium system between the tetramer molecule and its symmetrical αβ sub-units.

Two colloquia were also arranged, on widely differing topics. Prof. C. E. Dent (London) arranged a colloquium entitled "Inborn Errors of Metabolism", and Dr. L. Fowden (London) arranged one on "Biochemistry of Chloroplasts". Although obviously completely different in content, both were equally well attended and aroused considerable interest. In the other major event of the meeting, the Jubilee Lecture of the Biochemical Society, Prof. E. Lederer (Paris) discussed "The Origin and Function of Some Methyl Groups in Branched-Chain Fatty Acids, Plant Sterols and Quinones". Evidence was presented which indicated the origin of methyl and methylene groups in the compounds mentioned from either *S*-adenosyl methionine or propionic acid. The lecturer finally considered the possible role of quinones, each with a characteristically situated methylene group, in oxidative phosphorylation.

In addition to these events, the scientific programme also included the presentation of 139 short papers.

The scientific programme was accompanied by several social activities, among which were a conversazione attended by about 1,000 participants and guests, and a meeting dinner.

The size and scope of the meeting met with general approval, and the organization of it, for which Drs. S. P. Datta and W. J. Whelan were largely responsible, set a standard which subsequent organizers will wish to emulate. The Federation, the purpose of which is to encourage closer contacts between European biochemists, was thus given an auspicious start. General support from the Royal Society, the Wellcome Trust and numerous industrial companies must be acknowledged, as it contributed greatly to this success. It is planned to hold a meeting each year in a different country, and in 1965 the host country will be Austria.

I. R. Johnston

EARTH–IONOSPHERE CAVITY RESONANCES AND THE PROPAGATION OF EXTREMELY LOW FREQUENCY RADIO WAVES

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An account was given in *Nature* some years ago[1] of an experimental investigation on the propagation of audio-frequency radio waves around the Earth. In thoes experiments lightning flashes from distant storm centres were used as the source of the electromagnetic waves and, from an analysis of the spectrum of the radio atmospherics so produced, the attenuation of radio waves propagated between the ground and the ionosphere was deduced for the frequency range 100 c/s–16 kc/s. It was found that the spherical cavity between the ground and the ionosphere produced a marked attenuation at frequencies around 2 kc/s and that in the very low frequency band (3–30 kc/s) the attenuation decreased to a minimum value at a frequency of about 10 kc/s. In the extremely low frequency band (3 c/s–3 kc/s) below 2 kc/s the attenuation again decreased to a low value of about 2 db. per 1,000 km path at a frequency of 100 c/s. It was clear from these experiments that the attenuation of extremely low frequency radio waves was not only low but also was tending to lower and lower values as the frequency decreased below 2 kc/s. We were therefore left with the conclusion that signals radiated by lightning discharges would be propagated to greater and greater distances as the frequency decreased, in fact there existed the possibility of a standing-wave system or resonator type of oscillation in the cavity formed between the Earth and the ionosphere. From purely theoretical reasoning Schumann[2,3] first predicted the possibility of such resonances.

Earth–ionosphere cavity resonances were recently detected by Balser and Wagner[4], who, by a digital sampling technique, demonstrated that world-wide lightning discharges excited a noise spectrum which contained maxima and minima corresponding to the resonant frequency range of 7 c/s–c. 40 c/s. More recently, Gendrin and Stofant[5] have observed geomagnetic field resonances in the frequency range 0·2 c/s–30 c/s.

Our own observations in this region of the spectrum were chiefly undertaken in order to determine the manner in which extremely low frequency radio waves are propagated between the Earth and the ionosphere. In particular we wished to extend the attenuation curves of Chapman and Macario[1] down to lower frequencies since the propagation constant in this region of the spectrum was not known.

In order to examine the first few resonant modes of oscillation in the Earth–ionosphere cavity, due to world-wide thunderstorm activity it was necessary for us to determine the spectrum of the electromagnetic noise field in the frequency band ranging from about 4 c/s to 40 c/s, the upper limit being set to avoid interference from electric power lines. We have measured the radial (vertical) component of the electric field and have utilized three independent methods of recording. Use was made of a swept-frequency integrating spectrometer, waveform and magnetic tape-recording techniques. The results to be described are based on the records obtained