Little is yet known about the detailed physiology of vitamin C action, except that it is needed for the elaboration of the intercellular cementing substance, collagen, or, in a more general way, for the functional activity of the formative cells in general. Chemically, the vitamin is concerned in the conversion in the animal organism of folic acid (pteroylglutamic acid) into folinic acid, and in the metabolism of tyrosine. Vitamin C itself has intense reducing activity, but it has not yet been shown that its characteristic anti-scorbutic action can be attributed intrinsically to its redox properties.

Among various new points brought out at the Lind Bicentenary Conference, held in Edinburgh between May 22 and 23, was the suggestive fact, mentioned by C. G. King, that ascorbic acid may also have a role to take in the metabolism of cholesterol. At this meeting, contributions relating to vitamin C and allied topics were made by the following: Surgeon Vice-Admiral Sir Sheldon Dudley ("The Lind Oration"), Sir Edward Mellanby (opening remarks), Dame Harriette Chick ("Early Investigation of Scurvy and the Antiscorbutic Vitamin"), Dr. C. G. King ("The Discovery and Chemistry of Ascorbic Acid"), Dr. M. van Eekelen ("The Occurrence of Vitamin C in Foods"), Prof. H. A. Krebs ("The Sheffield Experiment"), Prof. S. B. Wolbach ("The Histology of Scurvy"), Prof. V. P. Sydenstricker ("The Impact of Vitamin Research on the Practice of Medicine"), Dr. J. H. Crandon ("Ascorbic Acid Deficiency in Human and Experimental Subjects"), Dr. R. M. Kark ("Ascorbic Acid in Relation to Scurvy, A.C.T.H. and Surgery"), Prof. E. J. Bigwood and Dr. J. P. Dustin ("Amino-aciduria in Infancy and Ascorbic Acid Deficiency"), Dr. C. P. Stewart ("Dehydroascorbic Acid in Human Blood Plasma"), Mr. A. J. Lorenz ("Pre-Lind Writers on Scurvy"), Dr. H. Gounelle and Dr. H. Teulon ("Contribution à l'étude de le Vitamine C dans certains états physiologiques et pathologiques chez l'homme"), Dr. W. J. Darby ("The Relationship of Ascorbic Acid to Tyrosine and to Hæmopoietic Vitamins"), Dr. L. W. Mapson and Dr. F. A. Isherwood ("Synthesis of Ascorbic Acid in Plants and Animals"), and Dr. Leslie J. Harris (chairman's summing-up). The proceedings are to be printed in full in a special, forthcoming issue of the *Proceedings of the Nutrition Society*. Obviously, anyone interested in the field of vitamins, whether from the separate aspects of biochemistry, physiology, dietetics or public health, will have need to consult this issue of the *Proceedings*. Together with the reprint of Lind's "Treatise", this record will form a fitting and permanent memorial to the pioneer whose memory was honoured at the bicentenary meeting.

HIGH-FREQUENCY ELECTRICAL MEASUREMENTS

CONFERENCE IN WASHINGTON, D.C.

THE third of the biennial conferences organized jointly by the American Institute of Electrical Engineers, the Institute of Radio Engineers and the National Bureau of Standards was held during January 14–16 in the Auditorium of the Interior Department in Washington, D.C. It was divided into four technical sessions dealing respectively with the measurement of frequency, length and time, power and attenuation, transmission and reception, and impedance. A list of the authors[1] and the briefest abstracts of the twenty-seven papers that were read would occupy the space of this article, and it will perhaps be preferable to select for more detailed treatment those subjects of particular interest to the writer.

Before the first session Dr. A. V. Astin gave a short address of welcome to the seven hundred delegates, and stressed the importance of the conference in helping specialists to keep abreast of this rapidly developing field of work. The chairman of the session, Dr. Harold Lyons, then introduced Dr. L. Essen, who described the frequency standards developed at the National Physical Laboratory, Teddington, their application to microwave measurements and, in particular, to the determination of the velocity of electromagnetic waves and the refractive indices of gases. The experiments involve the accurate measurement of both frequency and wave-length. Extensions of well-known techniques have given an accuracy of frequency measurement, throughout the radio-frequency spectrum, of one part in 10^8, and microwave optics have been developed to give an accuracy of wave-length measurement of one part in 10^6. Dr. Essen made use of a cavity resonator which is the microwave analogue of the Fabry–Pérot interferometer, while K. D. Froome used the analogue of the Michelson interferometer. The final accuracy that can be given for the value of the velocity of light, c, depends on the analysis and elimination of systematic errors due, in one case, to the imperfections of the surface of the resonator and, in the other, to the diffraction of the beam of radio waves at the transmitting horn and reflector. The values obtained are $299{,}792{\cdot}5 \pm 1{\cdot}0$ km./sec. and $299{,}792{\cdot}6 \pm 0{\cdot}7$ km./sec.

Dr. K. Bol then gave some previously unpublished details and the final result of the velocity determination initiated by Prof. W. W. Hansen at Stanford University. One of the main experimental difficulties had been the measurement of the length of the resonator, and this is probably mainly responsible for the spread of 2·2 km./sec. in the results. The final result of the measurements was given as $299{,}789 \pm 0{\cdot}5$ km./sec.

In view of the interest in the subject, a special discussion meeting was arranged by Dr. Lyons. The presence of so many of those concerned with the recent determination of the velocity of light would, he thought, afford a good opportunity for discussing the discrepancies between the various results, the question which is still sometimes raised of the variation of the velocity with time or frequency, and the best approach to a number of new measurements which are being planned. The result diverging most from the average of recent values is that obtained by D. H. Rank and his co-workers, from an examination of the infra-red and microwave spectra of hydrogen cyanide. Prof. Rank, although not at the meeting, had said earlier that there is some dissatisfaction with the wave-length measurements and that a new determination now in progress should give a considerably higher accuracy. In view of this and of some criticisms that were made about the way in which the final result is derived from the measurements, there was a general feeling that too much importance should not at present be attached to the discrepancy, although the method is one of great interest and potential importance.

The difference between the two cavity-resonator results was discussed at some length, but was not

satisfactorily explained. The technique employed at Stanford does not enable the effect of surface imperfections to be eliminated experimentally as it is in the work at the National Physical Laboratory, but Prof. E. L. Ginzton and Dr. Bol did not think that this effect could be large enough to account for a difference of 3 km./sec.

Commander C. I. Aslakson, who was responsible for the determination of the velocity of light by radar, thought that the precision could possibly be increased if the operators, drawn from the United States Air Force, were able to work on the project for a longer time once they had become skilled in the elaborate technique required to give a reliable result. J. E. R. Ross, of the Canadian Geodetic Survey, said that the average accuracy achieved in the use of radar for the rapid surveying of large tracts of land, the value of the velocity of light being assumed, was 5 parts in 10^5. Dr. Essen expressed the view that if systematic errors had been assessed more carefully, all the results for the velocity would be in agreement within the experimental limits and that there is therefore no evidence to justify speculations concerning the variation of velocity with either time or frequency. The probable error of the work at the National Physical Laboratory is $\pm$ 1 km./sec., and further work now in progress is likely to reduce it to $\pm$ 0·3 km./sec. Any future work designed to improve our knowledge of the velocity of light should therefore aim at an accuracy of at least 0·3 km./sec.

The work on velocity afforded an interesting application of cavity resonators. The two following papers were concerned with their more general properties, G. L. Hall describing the analysis and measurement of their circuit parameters and A. E. Wilson the techniques adopted at the National Bureau of Standards, Washington, D.C., for their rapid and accurate calibration as wavemeters.

The remaining part of the session was occupied by three papers dealing with frequency standards and measurement. T. A. Pendleton described an investigation at the National Bureau of Standards on the use of quartz standards as resonators. Their frequencies were measured daily, and it was hoped that the drift would be less than that of similar quartz units maintained in continuous vibration. To secure constant operating conditions, some of the resonators were housed at the bottom of 60-ft. shafts where the temperature was stable to about $\pm$0·001 deg. C. A. S. Bagley gave details of a new equipment for the measurement of frequency and time interval which was based on the use of counting-circuits operating at a rate up to 10^7/sec.; and finally W. E. Leavitt described an electronic chronograph readable to 0·02 msec. A further paper on frequency measurement was read at the last session. In this H. J. Finden gave an account of the extension of frequency synthesis and the production in a decade scale of standard frequencies up to 100 Mc./s. in steps of 1 kc./s.

At the next session, presided over by E. W. Houghton, there were three papers on power measurement and three on attenuation. In the first, M. S. Tanenbaum, dealing with the power that waveguide components can withstand without discharge breakdown, pointed out the need to express results on a statistical basis and suggested that the criterion of breakdown power should be that causing breakdown on 50 per cent of its applications. One of the difficulties of the tests at very high frequencies is the generation of the necessary power or voltage, and three ways of overcoming this have been used: a standing wave is produced in the guide to give voltage magnification; the dimensions in one direction of the guide are reduced; or the pressure is reduced by a known amount. From the results, the behaviour for normal conditions in the guide can be calculated. The lively discussion following this paper was evidence of the wide interest in breakdown problems. H. H. Grimm followed with a description of some pressurized, broad-band, water terminations used as calorimeters and concluded that the hairpin type, modified in order to reduce reflexions, gives the best performance, having a voltage standing-wave ratio of less than 1·03 for a power-level of 1·5 kW. and over a 5 per cent range of frequency. R. W. Lange explained some of the difficulties associated with bead thermistor power-meters. An instrument has been developed for 10 kMc./s. having full-scale sensitivities of from 4,000–40 μW. To achieve the accuracy required, it is necessary to select pairs of thermistors having not only the same characteristics but also similar ageing tendencies.

Attenuation measurements are based on the use of standard cut-off attenuators, and the precisely made microwave instrument described by R. W. Hedberg represents a useful contribution in this field. It employs the TE_{01} mode in a rectangular guide, and the effects of mode purity and mode filtering were fully discussed. A resistance card attenuator of novel form was described by B. P. Hand. The card is oriented in the waveguide at a variable angle with respect to the plane of polarization and gives an attenuation range of from less than 1 db. to 50 db. It is suitable for high frequencies at which cut-off attenuators are impracticable without frequency correction.

Most of the papers read at the conference were short accounts of original work, and two demonstration lectures given between the second and third sessions allowed the delegates a little mental relaxation. In the first, A. G. Fox showed how, in the millimetre wave-length range, dielectric waveguides can be used for flexible patchcards and other circuit components. He then gave a simplified explanation of Faraday rotation in a ferrite medium, using a most ingenious model of a spinning electron. A uniform magnetic field was simulated to produce precession, and a rotating magnetic field to produce a change in the angle of this precession. In the second lecture R. L. Wallace demonstrated some of the properties of a new high-frequency transistor. It enables instruments such as lapel microphones and hearing-aids to be made very small in size, and the total bulk of the batteries required to operate them for a period of a year was shown to be only a small fraction of that required by present-day instruments. The audience was left in no doubt about the importance which the new transistor will have when it becomes generally available.

A basic requirement in all high-frequency measurement work is the provision of suitable sources of oscillation, and three papers read at the session on transmission and reception, at which J. W. Kearney was the chairman, were concerned with this problem. N. A. Spencer described a waveguide cavity designed for the external tuning of the *RK*-5721 reflex oscillator tube. The mechanical tuning by means of non-contact plungers and the voltage adjustments are operated by a single control, and a range of approximately 8–10 kMc./s. is obtained with a power output of approximately 50 mW. S. F. Kaisel gave details

of a new type of oscillator, which can be tuned, by varying the voltages on the electrodes, over a frequency range of more than one octave. He also gave a survey of the frequency-ranges and power-levels obtained at various laboratories. In the millimetre region the difficulties of generation become very much greater, and quite new principles may have to be employed. There was no paper at the conference dealing with such investigations, but C. W. Johnson showed what can be done with existing equipment. An oscillator in the region of 24,000 Mc./s. (1·25 cm.) is fed to a crystal diode, and by careful adjustment of the circuits a usable amount of power at harmonic frequencies up to the tenth can be obtained. The cartridge of the crystal diode, of type 1*N*31 for example, is slotted near the crystal and is then fitted in a waveguide assembly so that the slot is across the small guide, in which the harmonics are generated. In an alternative form the diode is dismantled, and the crystal and cat's-whisker are connected directly across the waveguide carrying the fundamental frequency. The power obtained at 100 kMc./s. (3 mm.) is 10 μW., which is adequate for many purposes.

Later in the session C. F. Edwards gave an account of some tests on microwave noise-generators, which indicate that, after an initial ageing period, the microwave noise-output of a fluorescent lamp is remarkably constant; for example, a lamp with a relative noise output of 15·75 db. changed by 0·5 db. in the first few hours, after which no further change was detectable.

F. J. Gaffney presided over the last session, at which a wide range of impedance-measuring equipment was described. In many instances a rapid inspection of the matching of a transmission system is required rather than an actual measurement of impedance, and a very useful equipment for such purposes was described by W. P. Peyser. The frequency range covered by two instruments is 100–1,350 Mc./s., and an oscilloscopic presentation of the variation of voltage standing-wave ratio with frequency is provided so that adjustments to the component under test can be made to give the best performance over the required range. A relatively inexpensive slotted line for the measurement of impedance and standing-wave ratios was described by C. F. Miller. The line is approximately three metres long, the central conductor being supported by a thick-walled 'Styrafoam' cylinder. Some of the problems encountered in the conversion from balanced to unbalanced systems were considered by O. M. Woodward, jun., and a device for measuring the efficiency of the transformers used was described.

For the comparison and measurement of impedance in the microwave region, bridge methods using hybrid junctions are likely to be increasingly important, and M. D. Adcock's description of a new type of junction was therefore particularly interesting. The symmetrical arms of a conventional junction, or magic *T*, are arranged to be contiguous and parallel to the *H*-plane arm. A voltage standing-wave ratio of less than 1·1 for all arms is obtained with an isolation greater than 50 db. between the *E*- and *H*-plane arms. These figures hold for a frequency-range of 12 per cent, and the method of construction makes the power-handling capacity of the junction as high as that of the corresponding waveguide. In another interesting paper G. Deschamps showed how impedance measurements can be made on non-conventional guides such as microstrip by using standard equipment and correcting for the junction discontinuity.

In addition to the technical sessions, visits were arranged to the National Bureau of Standards, the U.S. Naval Observatory, the Naval Ordnance Laboratory and the Naval Research Laboratory; and a luncheon was held at the Hotel Statler. The guest speaker at the luncheon, Dr. A. T. Waterman, gave an interesting account of the work of the National Science Foundation and expressed some concern that, under present conditions, it has been necessary to allocate a considerable proportion of the funds of the Foundation to applied science instead of to fundamental research.

The keenness of the delegates, the strict adherence to the time-table and the smooth working of the organizational arrangements were features of this successful conference, and were evidence of the preparatory work of the joint committee under the chairmanship of Mr. E. P. Felch. It is, incidentally, a pleasure to record that the committee acted as most hospitable hosts to the overseas delegates.

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L. Essen

[1] *Proc. Inst. Rad. Eng.*, **41**, 172, titles only (1953).

SOUNDS OF JETS

By Dr. E. G. Richardson

King's College (University of Durham), Newcastle upon Tyne

The vibration of jets of water or gas issuing into the atmosphere has been a favourite study in classical physics for more than a century. Plateau was one of the early students of this phenomenon, and in his treatise, "Theory of the Modifications experienced by Jets of Liquid issuing from Circular Orifices when exposed to the Influence of Vibratory Motions", he showed that a column of liquid subject to surface tension undergoes rhythmic changes of figure of the type named by Lord Rayleigh as 'varicose'. Later, it was shown that the jet under vibration could also pendulate from side to side, both types of oscillation eventually causing the jet to break up into drops. A kindred study of the early days was that of the sensitive flame, a favourite topic of Royal Institution Discourses given by Tyndall. Shorn of the unessential combustion, this comprises a jet issuing from a narrow orifice without capillarity forces—that is, of a liquid into liquid or of a gas into gas—which, though inherently unstable, could have its instability rhythmically controlled by a sound.

None of these jets however, except some varicose water jets, has any preferred frequency. For this, some form of resonance or interference is necessary. The earliest form that this took was to let an air jet impinge on a sharp wedge. Such 'edge tones' were first heard by Sondhauss; and later Wachsmuth, noticing the relationship between this phenomenon and the diapason organ pipe, took photographs of the jet, to which ether vapour had been added. He showed that, if the distance from slit to edge is kept constant, and air at low pressure admitted to the wind chest behind the slit, the pitch of the edge tone rises with efflux velocity (with some jumps of frequency at certain pressures), while if the wind pressure is kept constant and the wedge moved away