The excessively high bactericidal values at first claimed for these compounds have now been disproved, having been shown to be due to micelle formation, clumping and residual bacteriostatic effects. These arise from their high surface activity and consequent intense adsorption to bacterial cells and other surfaces, an effect not easily removed by simple washing or dilution. Only by the use of suitable quenching agents, usually anionic compounds, can the effect be eliminated. The compounds generally are more active against Gram-positive than Gram-negative organisms. Suggested explanations of the mode of action of the quaternary ammonium compounds include the preferential destruction of the bacterial enzyme proteins, cytolysis of the cell with escape of intracellular substances, and final lysis resulting from surface action.

GASEOUS ELECTRONICS

CONFERENCE AT SCHENECTADY

THE fourth Conference on Gaseous Electronics, sponsored by the Division of Electron Physics of the American Physical Society, was held during October 4–6 in the new Research Laboratory at Schenectady of the General Electric Co. In the field of fundamental processes three main problems were discussed, namely, the role of rare-gas molecular ions, the formation of negative ions and photo-ionization in gases.

Using a new mass-spectrometer in which the kinetic energy of the ions is measured by applying retarding potentials after deflexion, H. D. Hagstrum (Bell Laboratories) reported that he has studied the critical energies necessary for electrons to produce various reactions by colliding with diatomic molecules, namely, carbon monoxide, nitrogen, oxygen and nitric oxide, and the nature of the ions formed. From the results, dissociation and electron attachment energies were derived. When a Townsend discharge, for example, in argon, is initiated by a light pulse of duration 10^{-7} sec. striking the cathode, it is found that the current as a function of the time decays in several steps. J. A. Hornbeck (Bell Laboratories) has shown that this phenomenon is associated with the neutralization of molecular and atomic ions at the cathode. From the measurements follows the ratio of the number of excitations to ionizations in various noble gases, as well as the product of the life of certain atomic states and the cross-section for excitation by electrons in a given field E/p. In the presence of molecular ions, similarity relations like Paschen's law fail.

M. A. Biondi (Westinghouse) has observed by microwave measurements the decrease with time of the concentration of negative ions in a decaying gas-discharge and derived from it the cross-section for thermal electrons of 0·04 eV. to become attached to oxygen molecules. In the pressure range 10–30 mm. of mercury, the cross-section seems to be independent of the pressure, and its value ($\sim 10^{-22}$ cm.^{2}) agrees with the theoretical one for radiative capture. A similar problem has been attacked by M. Harrison and R. Geballe (Washington University), who measured ionization currents in uniform fields between $E/p = 30$ and 80. The sharp apparent decrease of the ionization coefficient α/p with falling E/p at low fields is ascribed to the attachment of electrons to oxygen molecules which dissociate into O and O^-. This seems to be the case even in strong fields. T. Holstein (Westinghouse) said that he has treated theoretically the dissociative attachment by applying the Franck–Condon rule. For example, $O_2 + e \rightarrow O + O^-$ is such a process. It occurs in two stages : an electron is captured and the molecular ion dissociates. However, when dissociation occurs, the electron can become detached. The cross-section for the process has been calculated and agrees in order with the one computed for light atoms ; it contains the probability of auto-detachment which as yet is not known.

In order to determine photo-ionization cross-sections of molecular gases, G. L. Weissler and N. Wainfan (University of Southern California) use a spark source in helium at low pressure, producing lines of constant intensity in a vacuum spectrograph, and irradiate nitrogen and oxygen at low pressure. The ionization in the gas as a function of the wave-length is measured with an ionization chamber, and the energy of the radiation with a thermocouple. Preliminary results show that ionization in nitrogen occurs only below 800 A., corresponding to the ionization potential of the nitrogen molecule. A. O. McCoubrey (Westinghouse) reported on the band fluorescence of mercury vapour. Irradiation at 2537 A. produces atoms in the resonance state which collide with unexcited atoms and form metastable ones. These, too, collide with normal atoms, as a result of which metastable molecules are produced in a state that decays either by spontaneous or by collision-induced radiation. The former process is slow and gives rise to the ultra-violet band ; the latter produces the visible band. The ratio of the band intensities has been found to be proportional to the square of the vapour density, confirming the above processes.

C. F. Hendee (North Western University) has investigated the decay of the positive bands of nitrogen. A condenser charged to 10 kV. was discharged through a tube with external electrodes producing light-flashes. The emission of the first positive band is preceded by a transition from a metastable (singlet) into a normal (triplet) state. The decay involves collisions and thus takes ten times as long as the decay of the second positive band, which involves a normal singlet–triplet transition.

An account was given by A. V. Phelps (Massachusetts Institute of Technology) of his investigation of the ambipolar diffusion in a helium discharge by determining the electron density from the change of the resonant frequency of a cavity and the type of ions by means of a mass spectrometer. Below a pressure of 1 mm. of mercury, He^+ ions are formed which diffuse to the wall, and above 5 mm. of mercury, He_2^+ ions are formed. The large electron recombination coefficient is due to the molecular ions.

J. Slepian and L. S. Frost (Westinghouse) reported that they have found that measurements on the ambipolar diffusion in a decaying plasma can give results which do not agree with Schottky's theory. This is the case if the decay-rate is counteracted by ionization in the gas, or if the probe emits electrons, or if the charge density is not large enough to produce ambipolar flow, or if the pressure is so low that the mean free ionic path becomes comparable with the tube radius.

A series of papers dealt with questions concerning the discharge plasma. D. Gabor (Imperial College of Science and Technology, London) discussed the scattering of an electron beam which passes through a highly ionized and excited gas. He reported on the experiments by A. E. Ash, who measured the diffusion of a weak beam which passes along the axis of a cylindrical hot cathode coated inside with barium and strontium oxides. This layer emits positive ions which neutralize the electron space-charge. The evaluation of the experiments shows that the short relaxation distances cannot be explained by energy and momentum exchange between electrons colliding with ions and electrons. It is suggested that plasma oscillations are the cause of the strong interaction between beam and plasma.

I. B. Bernstein and T. Holstein (Westinghouse) gave an account of their theoretical investigation of the electron energy distribution in a constant (in time) space-charge field, the collisions and the superimposed A.C. field being treated as perturbations. The Boltzmann equation now contains the sum of electrostatic and kinetic electron energy which is constant, since the energy change per oscillation is assumed to be small. The resulting difference-differential equation has been solved. It was concluded that the space-charge field does not change materially the distribution or the rate of ionization for conventional values of the field (E/p), compared with results obtained for zero space-charge.

R. G. Fowler and D. Compton (University of Oklahoma) discussed their research on the properties of those luminous fronts—preceded by a shock wave—which are produced by low-pressure sparks with high peak currents. It is found that the speed of propagation is that of sound. The spectrum is not an afterglow. The gas has a high ion concentration as derived from Stark broadening. The spectral intensity is proportional to the square of the ion concentration, pointing towards radiative recombination.

A paper by J. Backus and N. E. Houston (University of Southern California) outlined their study of the energy distribution of positive ions produced by a pulsed glow discharge of duration 50 μsec. between copper electrodes in argon at about 1 micron pressure at 0·3 amp. in a magnetic field of 2,000 oersteds (Philips gauge). After the discharge was switched off, the ion current behind the cathodes was measured oscillographically, and from it the distribution was found to be nearly Maxwellian, the mean energy corresponding to about 1 eV. Another paper, by C. G. Smith (Raytheon), was on his continued studies on the retrograde motion of the cathode spot of an arc which is anchored to a 'Carboloy' cylinder projecting a few mm. above the surface of a mercury pool. The speed of the spot rises with the field, being considerably faster than sound in mercury vapour at 16,000 oersteds. However, the cause of the motion in the 'wrong' direction is still unknown.

G. Medicus and G. Wehner (WCESD, Wright Field) said that, by using an anode with a low work function (barium layer) and a hot cathode with a high one (tantalum) in xenon at a pressure of 0·2 mm. of mercury, they have observed a negative voltage drop develop across the discharge (0·8 V. at 0·5 amp.). The discharge is a low-voltage arc with a potential maximum between the electrodes; the negative p.d. is due to the contact potentials of the electrodes with respect to the gas. They gave a report on the errors in the evaluation of probe measurements which are due to changes in the work function of the probe. For example, when the tungsten probe is near a coated cathode, these changes occur so fast that it is necessary to make measurements with a probe a few seconds after it has been cleaned. However, by applying this technique, Maxwellian distributions of electron energies have been found to exist over a range of probe currents of 1 : 10^4 when the probe is 1 cm. from the cathode.

W. M. Webster (R.C.A.) found that at pressures greater than 1 mm. of mercury recombination at the surface of a probe becomes so appreciable that the concentration of charge as measured by the probe can be ten times smaller than in the undisturbed plasma. This can be demonstrated optically, or by using an electrolytic tank or by measurements at the wall of the discharge vessel. The electron temperature is found to be little affected. S. Schneider (Signal Corps, Ft. Monmouth) described how he has studied the clean-up in various parts of thyratrons filled with 99 per cent hydrogen and 1 per cent tritium at a pressure of 0·6 mm. of mercury; he uses β-ray counters and auto-radiographs. Preliminary results show that those parts of the surface which are covered with evaporated substances or are under strain bind tritium readily. M. J. Reddan and G. F. Rouse (National Bureau of Standards, Washington, D.C.) have measured the amount of helium which is absorbed by a nickel cylinder used as a negative probe in a hot-cathode arc discharge. At −100 volts one ion in three thousand will be absorbed by the probe. By heating a layer of nickel sputtered on to the glass wall, a large fraction of the helium can be recovered, whereas the gas which is driven into the probe is less easily liberated.

A report of an investigation of the audio- and radio-frequency oscillations produced by a hissing arc discharge in air, oxygen and nitrogen at atmospheric pressure was given by T. B. Jones and B. H. List (Johns Hopkins University). The former oscillations manifest themselves in arc voltage, current and sound, and occur at random; they are caused by the motion of the anode spot. The latter occur in narrow bands between 1 and 60 Mc./s. and are thought to be associated with the motion of positive ions in the plasma.

L. B. Loeb (University of California, Berkeley) presented R. P. Stein's measurements of the electric field in an abnormal glow discharge in air at pressures between 10^{-3} and 10^{-2} mm. of mercury and current densities of the order of 10^{-5} amp./cm.^{2} by observing the deflexion of a transverse 10-kV. electron beam. The field decreases nearly linearly with the distance from the cathode in agreement with Aston's results. Fields down to a few volts per cm. can be measured. Loeb also reported on E. J. Lauer's work on the discontinuous corona discharge between a positive platinum wire and a coaxial nickel cylinder in hydrogen and argon at pressures between 10 and 400 mm. of mercury. The discharges were initiated by α-particles shot axially through the gas near the nickel cylinder. The analysis of the current pulses shows that in hydrogen the liberation of secondary electrons at the cathode is essentially due to a photo-effect with a coefficient γ of the order of 10^{-3} to 10^{-4}. The contribution by positive ions is negligible. Small amounts of oxygen increase the photon absorption and reduce the secondary coefficient. In argon, photons do not contribute to secondary emission; only low-energy A_2^+ ions are effective, yielding a coefficient of about the same magnitude. The observed decrease of the coefficient with increasing pressure is probably caused by back diffusion of electrons in the low field of the cathode.

A paper by M. Menes and L. H. Fisher (New York University) gave an account of how they have measured the formative time-lag of a discharge on positive metal points (0·07–0·3 mm. radius) in dry air irradiated with ultra-violet light, the negative electrode being a plane at a distance up to 1·5 cm. They found that when the pressure was increased from 30 to 700 mm. of mercury, the time-lag at threshold potential decreased from 1 to about 0·1 μsec., depending only slightly on the radius, distance and illumination. This and the small lag indicate that the multiplication processes leading to the starting of a corona discharge are controlled by the gas.

The starting of a discharge between plane metal electrodes 1–4 cm. apart at pressures of less than or equal to 1 μ mercury and frequencies of 30–90 Mc./s. has been investigated by A. J. Hatch and H. B. Williams (New Mexico College), and they have observed that the starting field decreases with decreasing frequency as known for electrodeless discharges—until the cut-off frequency is reached. An avalanche of secondary electrons supplied by the electrodes is thought to initiate the discharge. However, when a strong field is quickly applied and then slowly lowered, a second field/frequency curve is obtained which lies above the first; this branch seems to depend on surface conditions and gas content of the electrodes.

A. von Engel (University of Oxford) dealt with the growth of an electrodeless discharge in high-frequency electric fields at very low pressure, based on work by G. Francis. From oscillograms of the discharge current and from theory, it is concluded that initially an avalanche of secondary electrons from the glass wall is formed, rising exponentially with time; then positive ions are produced in the gas, reducing the speed of impact of electrons on the walls and thus secondary emission. Finally, the ion concentration becomes so large that the amplitude of electron oscillation is reduced. The losses to the wall are ascribed to self-repulsion. A. VON ENGEL

COLOUR VARIATION IN THE BRUSH-TONGUED LORIES

AT a meeting of the British Ornithologists' Union held in the Zoological Society's lecture room on November 22, Dr. A. J. Cain, lecturer in zoology in the University of Oxford, gave a lecture on colour variation in the brush-tongued lories of the genus *Trichoglossus* inhabiting Australia and the islands of the South West Pacific, where the commoner forms are known as the blue mountain lory and the coconut lory. With specimens kindly loaned from the Reference Collections in the British Museum and by means of attractive Kodachrome slides, Dr. Cain showed that most of the random variation and distribution described by some authors for these birds could be explained satisfactorily in the light of modern evolutionary ideas.

Brightly coloured brush-tongued lories with striking orange and blue or scarlet and black undersides in almost endless variation live in flocks in open wooded areas, on islands from Bali to New Guinea with the Solomon Islands, and from Eastern Australia to the Caroline Islands. Much of the variation is correlated with local climate; but *Trichoglossus hœmatodus weberi* from Flores is a subspecies which is green all over, lacking the red and black underparts of *Trichoglossus hœmatodus mitchelli* from Bali and Lombok or the green and yellow underparts of *Trichoglossus hœmatodus capistratus* from Timor.

In Flores this subspecies of *Trichoglossus* lives quietly in the woods, clad in the sombre jungle green uniform of the forest dweller which seeks its food far and wide in the presence of its enemies. It has apparently changed its ecological niche.

In contrast, there lives on Ponape Island in the Carolines *Trichoglossus hœmatodus rubiginosus*, separated by nearly a thousand miles from its nearest relatives in the Solomon Islands. Except for its tail, it is a uniform, dull blood-red colour, with soft, silky plumage unlike the hard features of all the other forms. This subspecies meets no visual predators in its island and needs no recognition marks between friends, for there are no other lories or parakeets with whom confusion can occur. Consequently it has abandoned the usual coloration in the forms, which is cryptic dorsally and variegated ventrally.

VACUUM PHYSICS

FUNDAMENTALLY, the study of high vacuum is a branch of physics. However, following war demands, there has been a rapid development in recent years of large-scale and industrial applications of vacuum processes, and a new branch of engineering, in which high-vacuum technique dominates, has been developed. This new development, together with the considerable improvements in vacuum technique and equipment which have accompanied it, is not as widely known to research workers in the various branches of science as it deserves. The Midland Branch of the Institute of Physics is therefore to be congratulated on having taken the initiative in arranging an exhibition of modern vacuum equipment and a symposium on vacuum physics during June 27–28, 1950. The proceedings of the meeting have now been published by the Institute of Physics in a special supplement of the *Journal of Scientific Instruments**.

The exhibition and symposium were held in the University of Birmingham, at the invitation of Prof. M. L. Oliphant, and some two hundred members of university, government research and industrial laboratories attended. A wide range of pumps, gauges and associated equipment was exhibited by the leading manufacturers of vacuum equipment in Great Britain. The exhibits were attractively laid out and included many working models arranged for actual demonstration. The Physics Department of the University of Birmingham put on show some pieces of vacuum equipment of a specialized nature which had been developed to meet the requirements of the nuclear research programme carried out in that Department, and several conference members were given the opportunity of inspecting the large particle accelerators under construction in the Department. Altogether, eleven papers, each of which was followed by a lively discussion, were read.

The proceedings of the symposium may be divided into three sections which deal with the production and measurement of high vacua, leak detection and modern applications of high-vacuum processes respectively. In the first section, D. R. Goddard discusses in rather a general manner the

* *J. Sci. Instr.*, Supp. 1 (London: Institute of Physics, 1951; 15s.).