bear no relation to one another, either in their pattern of branching or at their points of attachment to the transverse bars. The smaller pit-areas which are thus formed between the individual threads do not entirely correspond with a similar region on the wall of an adjacent tracheid and are virtually blind in some parts (Fig. 3). Fig. 4, which has been redrawn from Figs. 1 and 3, shows this point particularly well.

The possibility that any two adjacent series of threads may have become slightly distorted or moved out of alignment with one another during fossilization or preparation of the cellulose nitrate 'peels' is precluded by the very little lateral movement which occurs when fractures break some of the threads. In addition, a number of tracings was made, but in no case was it possible to 'fit' the pattern of any set of threads with the corresponding series of an adjacent tracheid wall.

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PHYSICS OF ELECTRICAL DISCHARGE

DURING recent years the mechanism of the electrical breakdown of gases has been a subject of renewed interest. This is due to a variety of causes—in particular, the increasing use of compressed gases as a dielectric with high voltages (as in power cables), and experience with high-voltage machines for research in nuclear and medical physics. Recent work, especially in the United States, on the behaviour of compressed air has demonstrated the surprising fact that the breakdown strength does not increase as the gas pressure increases; this indicates a definite failure of Paschen's law. Increased interest in the mechanism of the electrical breakdown itself has also been stimulated by the desire to obtain a full explanation of the lightning flash.

The initiation and the mechanism of the electrical breakdown of gases was the general theme of a symposium on "Some Aspects of Discharge Physics" which formed the spring provincial meeting of the Physical Society, held at the University College of Swansea during March 29–31. The hundred and fifty scientific workers present, though mainly physicists, included a number of electrical engineers and mathematicians; and a large number of universities, government research establishments, industrial research associations, electrical and other industrial firms were represented at the meeting. The president of the Physical Society, Prof. L. F. Bates, in welcoming the members, pointed out that this was the first visit of the Society to Wales. On the afternoon of March 29 visits were made to the Abbey works of the Steel Company of Wales, and to the Gower Peninsula. On the morning of March 31 a tour of the Department of Physics of the University College of Swansea was made, and of the Sketty Hall Laboratories of the British Iron and Steel Research Association. Altogether, the success of the meeting showed the great interest now felt in discharge physics.

The symposium started with an address by Dr. A. H. von Engel (Oxford) on recent advances in the subject of fundamental collision processes. Examples of ionization by electrons and photons with energies less than the ionization energy were given; mercury vapour can be ionized by low-energy quanta producing two excited atoms which collide to form a molecular positive ion and a free electron. Again, auto ionization is an important cumulative process, for example, in metal vapours: first, two electrons are excited in the same atom, and one of them may then be released if the total potential energy of the atom exceeds the ionization potential. Further, two normal identical atoms may become ionized by collision if their relative velocity exceeds a critical value which corresponds to twice the ionization energy; this has been shown experimentally, and it agrees with classical laws of transfer of energy in collisions. Recent work on ion mobilities was then discussed: the disagreement between theoretical and experimental values of the mobility of positive ions of rare gases moving in their own gas has been found to be due to the formation of molecular ions (for example, He_2^+), which, unlike atomic ions, do not transfer their charges in collisions to neutral atoms. After discussing dissociative recombination, Dr. von Engel concluded by stressing that discharge physics is now entering a most interesting phase.

The next paper, given by Prof. Llewellyn Jones, was on the electrical breakdown of gases. From experimental investigations during the past twenty years, it had widely been concluded that the growth of pre-breakdown currents at high pressures followed a simple exponential law (involving no secondary ionization), and that to account for sparking it was therefore necessary to assume the sudden introduction of an entirely new ionization mechanism (streamer) not related to the growth of initial pre-breakdown currents[1]. This assumption was critically analysed by Prof. Jones, who showed that the experimental data were insufficient to justify such an assumption. The difficult experimental conditions which must be satisfied in order to investigate the problem over the significant range of spark parameters were discussed, and a high-voltage ionization chamber which has been designed and built to satisfy these conditions was described. With this apparatus, measurements have been made at Swansea of pre-breakdown ionization currents for values of the spark parameter *ap*, which included those corresponding to a 1-cm. gap in the atmosphere[2]. The results show that, while the growth of the currents is simply exponential over the greater part of the sparking distance, in the important region near breakdown itself the currents do, in fact, increase at the faster rate represented by an equation of the Townsend type involving primary and secondary ionization coefficients α and ω. This indicates that the mechanism of the spark itself is the same as that which leads to the growth of the photo-current even in its early stages ($i \sim 10^{-15}$ amp.). Possible secondary ionization processes were discussed in the paper—such as the ionization of gas atoms by photons, or by collision through the agency of positive ions involving electron transfer and the production of fast neutral atoms[3]; and also the cathode processes of secondary emission by positive ions or by photons. It was stressed that the essential feature of the breakdown mechanism is the development of the avalanche from behind by a secondary generating cause moving towards the cathode, a process which is most efficient when it acts at the cathode itself. Evidence was also given for the existence of secondary emission from the cathode by the impact of positive ions even with spark voltages up to 30 kV. W. Hopwood (Liverpool) then followed with a paper on the positive streamer mechanism. He pointed out that, in view of the experimental results of Llewellyn Jones and Parker[2] and recent work in the United States[4] on the formative time-lag of sparking in the important region near breakdown, some modification of the original streamer type theory is now required.

There was active discussion of these papers. C. G. Morgan (Swansea) dealt with the failure of Paschen's law at high voltage[5], and indicated that the intervention of cold-cathode field-emission is sufficient to explain this failure and also some experimental results of his own. R. Fortescue (Queen Mary College, London) raised questions on the interpretation of photographs of anode and mid gap streamers, on instability at breakdown and on the physical explanation of the influence of the cathode on breakdown at very high pressures. E. H. Cohen described recent high-voltage work done at Queen Mary College employing gas pressures of 1,000 lb./sq. in. S. Haydon (Swansea) gave theoretical considerations of photo-ionization in the gas; preliminary calculations with Dr. P. M. Davidson suggest that such processes do not predominate in the spark mechanism in air at high pressure; but for detailed calculations further numerical data on absorption cross-sections are required. J. Dutton (Swansea) discussed the interpretation of the results of recent work on formative time-lags[4], and showed that these are fully consistent with modern work on the growth of pre-breakdown currents, described above, and with the explanations proposed, concluding that a streamer mechanism is both insufficient and unnecessary to explain these results.

The session on March 30 opened with a paper by C. G. Morgan (Swansea) on the cold emission of electrons and discharge initiation. Cold emission from various electrode surfaces in air at atmospheric pressure under fields of the order of 10^5 volts/cm. has been found to depend strongly upon the nature of the electrode surfaces: thin oxide films or microscopic insulating particles give rise to enhanced electron emission[6]. Experiments have shown that the emission follows a field law. The role of post-breakdown residual positive ions in initiating succeeding sparks has also been examined, and it is concluded that a surface charge of positive ions on an insulating film at the cathode can give rise to enhanced field emission. This effect can lead to failure of Paschen's law. R. D. Craig (Metropolitan-Vickers Electrical Co., Ltd.) described experiments on the production of electrode vapour and its effects on the afterglow: 10 μsec. high-current pulse discharges were employed with electrodes of magnesium, copper, iron, carbon and tungsten. The observed large transport velocity of electrode material can only be explained if it leaves the electrode in the form of droplets or liquid jets.

In the discussion which followed, J. C. S. Shaw (Cambridge) pointed out that Mr. Morgan's views are consistent with present knowledge of backfires in rectifiers[7]. W. D. Chesterman (Admiralty Research Laboratory) described some of his experiments on the production of light flashes by the discharge of a condenser through a sealed quartz tube. G. G. Isaacs (G.E.C. Research Laboratory, Wembley) outlined work on high-pressure mercury vapour discharges, and showed that the cathode may give rise to effects extending far beyond what is usually regarded as the cathode region at these high pressures.

In the afternoon of March 30 there were four papers on high-frequency discharges. Dr. G. D. Morgan (University College of North Wales, Bangor) discussed breakdown and described experiments at Swansea made in hydrogen at low pressures p and at frequencies f between 5·0 and 70 Mc./s. to test the validity of a general similarity theorem: $V_s = \varphi(ap, f/p)$. The theorem holds accurately for breakdown, but less accurately for maintained high-frequency currents—this he attributed to discharge instability. G. Francis (Oxford) has found that the growth of electrodeless discharge at low pressure proceeds in three stages: the first stage is a multiplication of electrons by secondary emission from the glass walls of the vessel; the second is the production of a distributed positive space-charge of gas ions with a maximum at the centre of the vessel; finally, an equilibrium state is established when the production of ions and electrons in the gas equals the losses to the walls. A new technique has been used, and oscillograms showed how the growth of the discharge depends on the pressure and on the gas. W. L. Harries (Oxford) described the mechanism of the low-frequency electrodeless discharge in chlorine, and the influence of irradiation. He has found that the current consists of pulses, the number increasing with the voltage: each pulse corresponds to a series of electron avalanches developing between small areas of the inner glass surfaces. G. C. Williams (Swansea) described his work on the similarity theorem and corona relationship for both static and high-frequency discharges in air, hydrogen and monatomic gases; he also discussed the mechanism of the static corona discharge.

The symposium concluded with a paper by Dr. Elwyn Davies (Swansea) on the breakdown mechanism in static discharges at low pressures. He has examined the dependence of the shape of the cathode emission (ω/α) curves on the deposition of electro-positive or electro-negative atoms on cathodes of nickel, aluminium, silver, copper and molybdenum. Deposition of electro-positive atoms on the cathode produces sharp photoelectric peaks in the curves in the region $X/p \simeq 150$ V./cm. × mm. pressure of mercury; but at higher values of X/p the quantity (ω/α) is not greatly affected. Dr. Davies analysed these results in terms of the varying effective work function of the surface due to the deposition of atoms. He concluded that in hydrogen the high photoelectric emission from cathodes of low effective work function is due to low-energy photons generated in the pre-breakdown currents, but that for clean metals the secondary emission is due almost entirely to the impact of positive ions; photoelectric emission due to any high-energy photons generated in the ionization currents is negligible in comparison. Thus the breakdown process is almost completely determined by the nature of the cathode surface. The succeeding discussion included contributions from Prof. J. M. Meek (Liverpool) and J. R. Acton (Ericsson Telephones, Ltd.).

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REPORT OF THE COMMITTEE ON WEIGHTS AND MEASURES LEGISLATION

SOME important recommendations, of widespread interest, emerge from the deliberations of the committee appointed by the President of the Board of Trade to review the existing weights and measures legislation and administration in Great Britain. The report* presents the results of the first full inquiry into this subject since that of the Standards Commission of 1867–70. Not unnaturally, in view of the large amount of legislation which has since been effected, the recent committee, under the chairmanship of Sir Edward Hodgson, advocates a consolidation of the law in regard to weights and measures; but the chief scientific interest lies in Part 1 of the report, dealing with the units and standards of measurement. Foremost among the items of Part 1 is the recommendation that the Imperial system of units should eventually be abolished in favour of the metric system. This recommendation is unanimous and, as the committee says, contentious in the extreme. It visualizes a lengthy period to prepare the general public for the change and to provide schemes for the change-over, trade by trade, during a transition period extending over twenty years or more. But, above all, the recommendation is conditional on an approach being made to the Commonwealth and the United States, so that all may move together, or not at all.

When the Commission of 1867–70 examined this question, it recommended that the use of the metric system concurrently with the Imperial should be permitted for the purpose of trade. As a result of this recommendation, provision was made for the use of approved metric standards of weight and measure. In 1870 the metric system was compulsory in fifteen countries, but when the Hodgson Committee approached the matter, the number of such countries in the world had increased to fifty-five, the outstanding exceptions being the Commonwealth and the United States, which together conduct half, if not more, of the world's trade, using chiefly the yard–pound system. In the face of conflicting external factors and the mixed evidence submitted, the Committee found no easy solution. The real problem before it was whether to maintain two legal systems or to take steps to establish world-wide uniformity by changing completely to the metric system. The Committee, while bearing in mind the well-known objections to the change and in particular the difficulty of altering the units of measurement in the engineering and other industries, has resisted the arguments in favour of retaining the present concurrent use of both systems and has laid more stress on the part to be played by Great Britain in the international affairs of the future, in trade and commerce, defence, etc. The future needs of the country are not easily assessed, but at no time have smooth international dealings been so important as at present.

Much has been said on the subject by pro- and anti-metricists, as for example at the discussion at the British Association meeting in Brighton in 1948. It is hoped that any differences of opinion as to the Committee's recommendation will rise above the usual retorts as to the relative shortcomings of this or that set of units and reach a level where the significant factors are disentangled from the irrelevant. Looking back over a hundred and fifty years since the initiation of the metric system, we cannot close our eyes to its advance; and there is no indication that the trend towards its universal adoption has been reversed. It remains to be seen whether the Committee's long-term view on this subject will eventually receive sufficient support to overcome the inherent objections to the change.

The Committee, in making this recommendation, also envisaged the decimalization of the coinage, but this matter was considered to be outside its terms of reference. As a shorter-term proposal of the wider project, the Committee recommends that the apothecaries, troy and pennyweight systems of measurement should be abolished after five years and replaced by the metric system. This, though it might be regarded as a 'thin end of the wedge' for the long-term project, has the obvious advantage of removing from the Imperial system much unnecessary complexity of units; moreover, metric weights are normally used in scientific work.

Whether the long-term proposal to change to the metric system is accepted or not, strong support should be forthcoming for the recommendation that the independence of the Imperial and metric units of length and mass should be terminated, and that the yard and pound should be defined in law as definite fractions of the international metre and kilogram respectively. This proposal was put forward in 1946 by the British Empire Scientific Conference and has two main objects. The first is to remove embarrassments arising from the existing situation and particularly those caused by variations from time to time in the relationship of the material standards of the yard and the metre to one another, and also those of the pound and kilogram. The effect of the slight progressive shortening of the Imperial Standard Yard is sufficient to be felt in high precision measurements with engineering standards and in the surveying field. The second object is to eliminate the small differences which exist between the Commonwealth and the American yards and pounds. The differences have arisen because these units have been defined in Britain by reference to independent standards, whereas in the United States, ever since 1866, they have been defined by fixed ratios to the metre and

* Board of Trade. Report of the Committee on Weights and Measures Legislation. (Cmd. 8219.) Pp. iv+147. (London: H.M. Stationery Office, 1951.) 3s. 6d. net.