Fig. 4. Crystals of cadmium azide (a), and α -lead azide (b), which are decomposing thermally. Note cracking and splitting along crystal axes

It will also influence the rate of thermal decomposition by exposing a large amount of fresh surface.

Crystal Size and Impact Sensitivity (with A. M. Yuill)

From similar considerations we may expect that the impact sensitivity of a crystal will be dependent upon its size. If the crystal is too small, the reaction will not be able to grow to explosion and the initiation will then, apparently, be unsuccessful. Mr. A. M. Yuill has investigated the effect of crystal size on the impact sensitivity of lead azide. Single crystals of the azide were placed on an anvil and struck with a flat-faced hammer, using an apparatus described elsewhere. The results are illustrated in Fig. 5.

Curve 1 is for individual crystals, and it will be seen that below a certain size the impact sensitivity is very dependent upon the size of crystal. For a crystal of 8×10^{-2} cm. in size, the impact energy for a 50 per cent probability of explosion is c. 5 kgm.cm.; as the crystal size is decreased, the necessary impact energy increases, and with a crystal of about

Fig. 5. Influence of crystal size on the impact sensitivity of lead azide; (1) single crystals; (2) heap of crystals

1×10^{-2} cm. it has risen to 200 kgm.cm. If, however, a heap of crystals of uniform size is used (curve 2) the impact sensitivity is independent of the size of the individual crystals in the heap and remains approximately constant at 2 kgm.cm. over this size-range. There may be two factors involved. First, the probability of explosion is determined by the number of potential initiation centres or hot spots, and this is naturally greater for large individual crystals than for smaller ones. The second is the effect discussed above: the reaction cannot grow to explosion unless the crystal exceeds a critical size. This critical size is dependent upon the initial hot-spot temperature and hence upon the impact energy. It should be noted that, under impact, the single crystals are crushed and flow plastically to form a pellet the thickness of which is about one-tenth to one-quarter that of the original crystal. If, therefore, the explosion starts at a late stage of the impact, it may be this thickness which is the limiting factor.

These experiments provide strong evidence that the explosion nucleus must exceed a critical size (which is quite large and is determined primarily by thermal considerations) before it can grow to detonation. Earlier work¹ has shown that, in addition to being a precarious process, the growth can be complex. For many explosives it begins as a comparatively gentle burning which accelerates to a few hundred metres a second before passing over into detonation, and the successful growth of the explosion requires critical conditions. The propagation of the low-velocity detonation is itself assisted by air bubbles and other sources of local hot spots². The chemical reactions occurring during this burning phase are different from, and less complete than, the decomposition in detonation³. With metallic azides this intermediate burning stage is not observed. Very frequently, in sensitivity tests and in practical operation, the failure of an explosion to take place is due, not to a failure in initiating the reaction, but simply to a failure in the growth process.

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³ Van't Hoff, J. H., "Études de Dynamique chimique" (1884). Frank-Kamenetski, D. A., *Acta Phys.-chim., U.R.S.S.*, **10**, 365 (1939). Rice, O. K., *J. Chem. Phys.*, **8**, 727 (1940).

⁴ Rideal, E. K., and Robertson, A. J. B., *Proc. Roy. Soc., A*, **195**, 135 (1948).

⁵ Garner, W. E., *J. Chem. Soc.*, 720 (1934).

⁶ Kallmann, H., and Schrankler, W., *Naturwiss.*, **21-23**, 379 (1933).

⁷ Muraour, H., *Chim. et Indust.*, **30**, 39 (1933).

⁸ Meldrum, F. R., *Proc. Roy. Soc., A*, **174**, 410 (1940).

⁹ Bowden, F. P., and Williams, H. T., *Research*, **4**, 339 (1951).

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WILHELM OSTWALD (1853-1932)

By PROF. J. R. PARTINGTON, M.B.E.

SEPTEMBER 2 is the centenary of the birth of Wilhelm Ostwald (1853-1932), one of the most influential physical chemists of the second half of the nineteenth century. His own investigations of chemical equilibrium convinced him of the importance of the general law of mass action proposed by Guldberg and Waage in 1867, and from 1887 he welcomed the new theories of solution of van't Hoff, of electrolytic dissociation of Arrhenius, and of galvanic cells of Nernst. Ostwald introduced chemists to the use

of thermodynamics (which he tried to simplify in his system of 'energetics'), and was the first to emphasize the importance of the little-known publications of Gibbs and the value of the phase rule. These aspects of physical chemistry led him to under-estimate the importance of the atomic theory, but he recognized its significance after the work of Perrin on fine suspensions, and the discovery of radioactivity, had given it what he regarded as an experimental foundation. His own work on catalysis had led him to formulate the main features of the phenomenon in a manner which emphasized the observed facts and minimized the unverified (or unverifiable) and unnecessary hypothetical interpretation of them. This method of approach was typical of his outlook.

In his time, Ostwald was an international authority and his influence was comparable with that of Berzelius in an earlier generation. Many chemists, before adopting or using new theories, waited first to see what Ostwald would say about them and to what form he would reshape them to suit chemical requirements. His books, especially the smaller "Outlines of General Chemistry" and its many translations, were a powerful stimulus to the study of the newer physical chemistry, and his influence can be traced to-day in many directions, although its origin may not be adequately recognized. He was pre-eminently a clarifier and systematizer of knowledge, and an indefatigable defender and exponent of the newer physical chemistry based on the theories of solutions and electrolytic dissociation. His insistence that physical chemistry is a study equal in rank to any other branch of chemistry was necessary and important. Whole branches of chemistry now taught as commonplaces won their way into the science only after prolonged battles against either determined opposition or studied indifference. In maintaining their claims, Ostwald was much to the fore.

Ostwald was a man of many interests, in literature, music and art as well as in science. He devoted much time to the development of a colour scale and of an international language. He was greatly interested in the history of science and founded the "Klassiker" series. He believed that a historical approach had a disciplinary value. His many pupils venerated him and his influence in physical chemistry was fruitful and beneficial in many ways. It can be said with truth that physical chemistry owes very much, both directly and indirectly, to the research and teaching of Ostwald.

OBITUARY

Prof. F. H. Rein

THE death of Prof. F. H. Rein occurred at the age of fifty-six on May 14, at Göttingen, where he had occupied the chair of physiology from 1931 until 1953. He had recently resigned on his appointment as director of the Max-Planck Institute for Medical Research in Heidelberg, but had not actually taken up his new post.

Rein's scientific work consisted mainly in the application of ingenious physical and mechanical principles to physiological problems, and among the results of this work were the 'Thermostromuhr' and the 'Stoffwechselschreiber'. The 'Thermostromuhr' has since been criticized, and certain of its limitations have been shown; but in Rein's

hands it made possible the investigation of many problems of the circulation as shown by the long series of publications from his Institute. It was a tragedy that Rein reached the peak of his ability when the position in Germany was becoming unfavourable for scientific work, and when international scientific relations were becoming difficult and finally impossible. When he gave a series of lectures in London in 1937 on the relation between metabolism and blood flow, he greatly appreciated the contact with English workers and was deeply concerned with the increasing difficulty of getting more interchange between Great Britain and Germany. The complete separation of the two countries during 1939-45 was followed by a great increase in the growing tendency in Britain to look to the United States rather than to the Continent for scientific exchange. This combination of circumstances has made Rein's work less widely known and appreciated in Britain. In addition to his numerous original papers he wrote a "Text Book of Physiology" which reached ten editions and is widely used in Germany. He was also senior author of the Physiology Section of the Fiat Reviews of German Science during 1939-46.

In his private life Rein was undemonstrative and somewhat reserved; but he inspired an intense loyalty in his younger colleagues, a number of whom now occupy chairs of physiology in Germany and elsewhere. Beneath his reserve he was extremely friendly, and he and his wife entertained the workers and visitors at his Institute with a kindly hospitality. His services to the University at Göttingen were great. He was responsible for the new Institute of Physiology which was completed in 1938. After the War he acted as rector of the University at a very difficult period, and he did much for the rehabilitation of the University. He was also one of the founders of the Fridtjof Nansen House in Göttingen, which was a centre for international student activities.

D. H. SMYTH

NEWS and VIEWS

Royal Aeronautical Society: Medal Awards

THE following Medals have been awarded by the Royal Aeronautical Society and will be presented at a meeting at the Royal Institution, London, on September 14: *Society's Gold Medal*, which is the highest honour that the Society can confer, to Mr. E. F. Relf, for his outstanding contribution to aeronautical science over a period of many years; *Society's Silver Medal*, to Mr. H. Grinstead, for his outstanding work in aeronautical engineering; *Society's Bronze Medal*, to Mr. L. Boddington, for his work on the development of naval aircraft; *British Gold Medal for Aeronautics*, to Mr. R. E. Bishop, for his outstanding contribution to aircraft design; *British Silver Medal for Aeronautics*, to Mr. J. E. Gordon, for his excellent work in the sphere of aircraft structural plastics; *Wakefield Gold Medal*, to Mr. F. W. Meredith, for his work in the design of automatic pilots and aircraft instruments; *Simms Gold Medal*, to Major P. L. Teed, for his paper on "Fatigue of Aircraft Materials with Special Reference to Micro-Structure"; *George Taylor (of Australia) Gold Medal*, to Group Captain E. A. Whitely, for his paper on "The Spacing of Aircraft under High Density Approach Conditions".