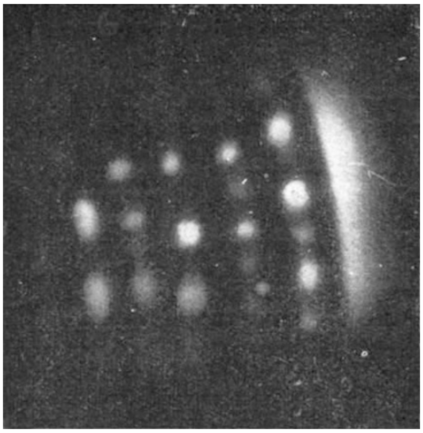

Fig. 4

This one change, however, would not result in ideal image formation, for the defects of a small field, oblique focal surface, and non-uniform magnification would still be present. It now appears that these faults cannot be remedied in any single system like that pictured in Fig. 2, and that compound systems, containing at least two pairs of mirrors, must be employed. We have made some progress with the theoretical optics of such systems and are now engaged in experimental tests. So far as we have been able to learn, grazing-incidence image formation has been completely neglected by optical theorists. One may hope that the possibilities of X-ray microscopy will attract theoretical workers to the problems of these compound, aspherical, anaxial systems.

The small wave-lengths of Röntgen radiation provide the possibility of high resolution, but X-ray microscopy as at present conceived shares with electron microscopy the restriction to very small angular apertures. In the case of X-rays, the aperture angle is flatly limited by the critical angle of total reflexion. The angular limitation may be raised by utilizing rays of greater wave-length; but the net effect upon resolving power is nil. It can be shown that the theoretical maximum resolving power is such as to separate point objects about 70 A. apart. Such performance would require perfect mirror surfaces of the best material now known to exist, and would require that the optical system be filled with coherent radiation. We do not yet have a design which could be expected to approach such characteristics.

The lack of dependence of resolving power upon wave-length leaves the choice of radiation open to other considerations. There are strong reasons for choosing a rather soft radiation: the critical angle increases with the wave-length, and this simplifies certain aberration problems and makes for better light-gathering and hence more photographic speed. Although the magnified X-ray image can be viewed on a fluorescent screen, an adequate photographic exposure on fine-grained film requires many minutes with our present X-ray sources. Soft radiation has the further advantage of providing good contrast when used for the observation of thin specimens of organic material. We have photographed many images with radiation of wave-length between two and three angstroms. Such radiation is so soft as to be strongly absorbed by air, so we enclose the entire optical system in a container filled with helium at a pressure of one atmosphere. Final focusing in all our optical systems is accomplished by tilting the mirrors slightly by means of a micrometer control so as to vary the angle of incidence and hence the focal length.

Reflecting systems are free from chromatic aberration, so from the point of view of image formation there is no reason to desire monochromatic radiation. In thin specimens, however, contrast is impaired by hard components in the beam, so there would seem to be advantage in the use of a high-pass filter which would remove the short waves. But this is precisely the effect of total reflexion at the mirrors; wave-lengths greater than a critical value, dependent upon the material of the mirror and the angle of incidence, are strongly reflected and shorter waves are absorbed in the mirror. Thus we have available a selective process furnishing a considerable degree of voluntary control over image contrast.

Although it does not now seem possible that X-ray microscopy can attain the resolving power which has already been reached by electron microscopes, the X-ray methods have other features which may reserve for them a unique field of usefulness. In X-ray examination of biological materials there would be no necessity for subjecting the specimen to the desiccating action of high vacuum. The range of penetrating powers available in the X-ray spectrum is extremely wide, meeting the demands of biologists on one hand and of metallurgists on the other. Furthermore, the absorption of X-rays is so specifically characteristic of the absorbing element that one may speculate hopefully upon the possibility of microscopic chemical analysis through photographic observation with a succession of approximately monochromatic radiation bands.

OBITUARIES

Admiral Sir A. Mostyn Field, K.C.B., F.R.S.

THE passing of Admiral Sir A. Mostyn Field, who died on July 3 at the age of ninety-five years, severs one of the few remaining links with a period conspicuous for the achievements of British seamen in the field of hydrography. He entered the Royal Navy as a cadet in 1868, and at the examination for lieutenant in 1876 he obtained the unique distinction of full marks in navigation and pilotage, being awarded the Beaufort Testimonial. In the same year, the year following the return of the *Challenger* Expedition and the year of the return of the last officially sponsored British Arctic Expedition in the *Alert* and *Discovery*, Field commenced his career as a hydrographic surveyor and spent the next twenty-three years almost continuously surveying in foreign waters. Many of his surveys remain the sole authorities for the areas concerned. During 1876–80 he served in the *Fawn* under Commander W. J. L. Wharton, surveying on the east coast of Africa, in the Mediterranean, Red Sea and Sea of Marmora. In 1881 at the youthful age of twenty-six he was employed on detached duty surveying the entrances to various rivers in the Niger Delta, after which he joined the *Sylvia* for surveys in the Magellan Strait and later on the east coast of South Africa.

Field obtained his first command, still as a lieutenant, in the *Dart* in 1885, and during the ensuing four years executed a large number of surveys, mainly

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in New Guinea and the off-lying islands and in Tasmania. As a commander, in charge of the *Egeria*, he spent the years 1890–94 on surveys in Borneo, Hong-Kong, Singapore, and Malacca Strait. Promoted to captain in 1895, he resumed sea service in 1896 in command of the *Penguin*, in which during the next three years he made a number of surveys in the North and South Pacific and on the Australian coasts. Among these was the well-known survey and borings at the Funafuti Atoll under the auspices of the Coral Reef Committee of the Royal Society in 1897. This was the end of his foreign service. During 1900–4, in command of the *Research*, he carried out surveys mainly in Irish and Scottish waters.

In 1904 he succeeded Rear Admiral Sir William Wharton as hydrographer of the Navy. During his five years period of office he continued the large programme of surveys at home and abroad in the tradition of his predecessors ; one of the most notable was that of Scapa Flow with a view to its use as a fleet anchorage, a proposal first submitted to the Admiralty by Graeme Spence in 1812. By increasing and raising the status of the civilian technical staff within the Hydrographic Department, Field greatly increased its capacity to utilize for British hydrographic publications the results of foreign hydrographic surveys which had steadily grown in number and quality since the end of the nineteenth century. Subsequent needs in the First World War amply vindicated his vision.

Field wrote easily and with clarity. He contributed numerous articles on hydrographic surveying, its methods and apparatus to various scientific journals and the "Encyclopedia Britannica" (tenth edition). He revised and enlarged Wharton's famous original work "Hydrographic Surveying" for the third and fourth editions in 1909 and 1920. He was elected a fellow of the Royal Society in 1905 and made K.C.B. in 1911.

After vacating the post of hydrographer of the Navy, Field served as Admiralty representative on the Port of London Authority during 1909–25, as acting conservator of the River Mersey 1910–30 and as nautical assessor to the House of Lords. In his private life he took a great interest in the problems concerning science and religious dogma, and he maintained an active correspondence with a number of theologians pressing for changes in doctrine which would admit many more men of science into the Anglican Church. G. B. S.

Dr. R. V. Norris

Dr. Roland Victor Norris died at Port Shepstone, South Africa, on April 28, at the age of sixty-two. He went to South Africa in November 1949 on holiday, and was due to return to the Tea Research Institute of Ceylon, of which he had been director since 1929. His death is a sad loss to the Institute he served so well, and a personal misfortune to his many friends, among whom may be included the whole of his staff.

After graduating from the University of Manchester, Dr. Norris became private assistant to Prof. W. H. Perkin. Moving to the Lister Institute of Preventive Medicine, London, in 1910, he joined Prof. Arthur Harden's school and took part in the classical researches on the mechanism of alcoholic fermentation by yeast enzymes, for which work he was eventually awarded the D.Sc. degree of the University of London. In 1912, while at the Lister Institute, he was elected to a Beit Memorial fellowship.

Dr. Norris's long career in the East began in 1914, when he accepted the post of physiological chemist at the Imperial Bacteriological Laboratory in India. His first administrative experience was gained in the Indian Army, in which his administrative abilities were soon recognized after a brief period of active service in 1915. From 1918 onwards, Dr. Norris gradually turned towards agricultural research, first becoming agricultural chemist to the Government of Madras. When professor of biochemistry in the Indian Institute of Science, Bangalore (1924–29), his research students were largely occupied with biochemical problems relating to agricultural subjects such as soils, plants, manures, the lac industry and the spike disease of sandalwood.

In 1929, Dr. Norris was appointed to the directorship of the Tea Research Institute of Ceylon, when the construction of the permanent quarters at St. Coombs was just starting. The Institute has grown from its foundation on St. Coombs Estate to its present status under his guidance, and will be a memorial to his industry so long as it exists.

'R. V.', as he was known to his colleagues, was by no means a pedant. He was a widely travelled and well-read man of many interests. He was actively interested in sports, particularly rugby and hockey, and took a full part in many social activities. In his later years he became keenly interested in freemasonry and achieved the rare distinction of occupying the chairs of two Lodges under the English Constitution and one under the Irish Constitution.

European, Indian and Singhalese colleagues of two generations, and many members of the tea industry, will remember 'R. V.' with affection. Having worked under his direction for sixteen years, I can pay tribute to his tolerant but firm direction, critical but staunch support, and his fatherly guidance and encouragement. J. Lamb

Dr. Otto A. Beeck

Dr. Otto A. Beeck, associate director of research, Shell Development Co., California, died suddenly on July 5. He was born on October 21, 1904, in Stettin, Germany. He was educated in Europe, following which he was post-doctorate research fellow at the California Institute of Technology during 1930–33, serving also as instructor. He joined the Shell Development Co. at Emeryville, California, in 1933 and organised there a broad programme of fundamental research in physics and related aspects of chemistry. He became head of the newly created Physics Department in 1936 and was made an associate director in 1942.

Prior to joining the Shell Development Co., Dr. Beeck carried out research in gas discharges. Since then he has engaged in research on catalysis, the physics and chemistry of surface phenomena, the study of reaction mechanisms by tracer methods, and the fundamentals of lubrication. He was a member of the National Research Council's Committee on Catalysis and of the Sub-Committee on Lubrication, Friction and Wear of the National Advisory Committee for Aeronautics. He was active also on the Advisory Council of the American Institute of Physics.

Dr. Beeck was interested in art, photography and ski-ing, and was an amateur farmer and horse fancier.

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