antiquity was published in 1927. His early medical period closed in 1928 with the publication of his "Short History of Medicine".

Singer's interest in the history of science was at first confined largely to biology and the history of microscopy. The first volume of his "Studies in the History and Method of Science" (1917) contained papers by him which were medical rather than scientific; but the second volume (1921) contained his very important study of Greek biology, and also his paper on the invention of the first optical apparatus. Thereafter he published (1922) his useful little book on "Greek Biology and Greek Medicine". After that, occasional papers on biological and scientific subjects began to appear, and in 1931 he published—as a result of his American lectures—his "Short History of Biology", one of his best books, which he afterwards revised twice.

After this, it was ten years before Singer published another important book. In the intervening period he had spent nearly a year in the United States, had removed to Cornwall, and had written many articles and reviews. He had also played a prominent part in the foundation of the Society for the Protection of Science and Learning, for he was deeply saddened by what happened to European scholars before the outbreak of the Second World War. He had also been reading widely in the literature of science, and the result was his "Short History of Science", published in 1941. This work was much read because it covered the whole field to 1900 within reasonable compass; it introduced a new approach and was easily understood. Towards the end of the War he worked on the "Tabulae anatomicae sex" of Vesalius, and later he completed the philological aspects in collaboration with Prof. Chaim Rabin. This work was published in 1946 as "A Prelude to Modern Science".

In the closing years of the War, Singer was asked by Mr. Derek Spence to write the history of the alum trade; Mr. Spence's well-known firm, dating back to 1855, contributed much to the later history of that trade. For Singer this was a new departure, and he devoted several years of enthusiastic work to this effort. The result was the fine folio volume, "The Earliest Chemical Industry", published in 1948.

Singer next turned to three medical projects which had long been in his mind. The first was the completion, in collaboration with his old friend, Prof. J. H. G. Gratton, of a definitive text of the Anglo-Saxon work known as the "Lacnunga". This work was published in 1952, as also was the second of these projects, a translation of the seventh book of the "Fabrica" of Vesalius.

The need for an authoritative work on the history of technology had long been understood by Singer, and after the publication of his work on the alum trade he devoted much time to the planning of a co-operative work on this subject. The drawing up of these detailed plans for five large volumes must be considered as one of Singer's finest pieces of work. It gave him scope for the use and display of his vast knowledge of men and books, and for the extensive correspondence in which he delighted. Although he had associated editors, chief of whom was the late Dr. E. J. Holmyard, Singer played the main part in the planning and editing of this work. The first volume was published in 1954, and the fourth and fifth volumes in 1958. During its publication he completed and published his last original medical work, his annotated translation of "Galen on Anatomical Procedures" (1956).

In 1922 Singer was awarded a D.Litt. at Oxford for his thesis on the manuscripts dealing with St. Hildegard of Bingen. He already had the Oxford D.M. (1911), and in 1936 that University conferred on him the honorary degree of D.Sc. He became a Fellow of the Royal College of Physicians in 1917. Later in life he became a Fellow of University College, London, an Honorary Fellow of the Royal Society of Medicine, and an Honorary Fellow of his old college, Magdalen, at Oxford. He delivered the L. T. Hobhouse Memorial Trust Lecture in 1951, and the Lloyd Roberts Lecture in 1954. He was president of the History of Medicine Section of the Royal Society of Medicine during 1920–22, and first president of the British Society for the History of Science (1946–48). He was also president of two International Congresses held in London (History of Medicine, 1922; and History of Science, 1931). In 1947 he was president of the International Union for the History of Science. He was awarded the Osler Medal and the George Sarton Medal. In 1953 Singer was the recipient of a large work containing historical essays written in his honour ("Science Medicine and History", 2 vols.; London, 1953).

Singer was by inclination and training a biologist, and to the end of his life he rather regretted that he had not taken up this subject as a profession. When the King's School at Canterbury was evacuated to the west of England early in the Second World War, he was induced to take over the teaching of practical biology. For this purpose he had a room in his house fitted out as a laboratory, and during most of the War he taught in it pupils attending that and another school. It gave him great satisfaction that he consistently obtained a very high standard of passes. In botany, Singer was especially interested in the succulents, and in front of his desk there stood a thriving array of these plants.

Charles Singer will be remembered as much for the encouragement which he gave to others as for his own numerous and important contributions to his subjects. His large correspondence testified to the advice which he gave. But his inspiration and encouragement flowed most easily in his conversation. Those who knew him well appreciated that, despite his learning, his humanity was perhaps the outstanding feature of his character. He had a rich fund of humour, and he could talk simply to the unlearned about subjects which were by no means simple. His studies in the local history and customs of Cornwall were unpublished, and were probably known to very few except his Cornish neighbours.

E. ASHWORTH UNDERWOOD

Dr. Geoffrey Builder

THE sudden death of Geoffrey Builder at the early age of fifty-four has deprived the University of Sydney of an original and sympathetic teacher of physics and Australia of a scientist of international reputation. Born in Western Australia, he was educated at Guildford Grammar School, the Perth Technical College and the University of Western Australia. After graduating in 1928 he joined the Watheroo Magnetic Observatory of the Carnegie Institution of Washington and was responsible for developing a radio technique for the rapid transmission of geophysical data to Washington.

In 1931 Builder commenced work under me at King's College, London, on the exploration of the ionosphere, in which researches he was largely responsible for the discovery of the magneto-ionic splitting of pulse radio echoes and the quantitative verification of ionospheric double refraction which had been predicted by a theory of mine. During July 1932–May 1933 he was a member of the British Radio Expedition to Tromsø, in North Norway, organized by the Royal Society as part of Britain's contribution to the work of the Second International Polar Year. It was this expedition which discovered the phenomenon of the polar radio 'black-out', associated with magnetic storm and auroral activity.

After obtaining the London degree of Ph.D., and becoming a Fellow of the Institute of Physics, Builder joined the Australian Radio Research Board in the latter part of 1933. He then played an important part in developing the Board's new experimental techniques for ionospheric exploration and collaborated with the late A. L. Green in researches on the polarization of long radio waves and on the suppression of fading.

Towards the end of 1934 he joined Amalgamated Wireless (Australasia), Ltd., to take charge of its small group of research laboratories. Under his energetic and skilful direction this group developed rapidly until, at the time of his departure for the Army in 1941, it had grown into an effective organization with more than fifty members of staff. Many well-known Australian radio-physicists and engineers owe their selection and early professional training to the shrewd judgment and scientific and administrative capacity which he exercised during this period as chief of research.

While a major at Army Headquarters during part of the Second World War, Builder acted as adviser on radar, and later engaged in defence production as general manager of Airzone, Ltd. After the War he worked as a consultant and founded two electrical engineering companies. During part of this time he was able to give valuable assistance to the Department of Physics of the University of Sydney in coping with its excessive load of teaching. In 1949 he was appointed to the permanent staff of the Department as a senior lecturer and devoted himself largely to giving lectures on electricity and to the duties of the lecturer-in-charge of second-year physics.

As a member of the Faculty of Science he was very active in proposing various reforms and successful in getting many of them adopted. In recent years he developed an interest in the theory of relativity and gave much time and thought to resolving the famous clock paradox of the special theory. These researches were carried out with his usual thoroughness and acumen and, although at times they brought him into conflict with well-known theoreticians, one of his last papers[1] appears to have settled the controversy by showing that "the clock paradox . . . arose solely out of the elementary mistake of utilizing, in a single calculation, quantities expressed in the measures of two different reference systems". Such versatility and depth are not often found among the younger generation of physicists.

Builder's great interest in the welfare of his students, both collectively and individually, and his exceptional combination of technical, commercial and academic experience made him one of the most successful of teachers and a constant source of wise counsel to his academic colleagues.

EDWARD V. APPLETON

[1] *Amer. J. Phys.*, **27**, 656 (1959).

Georges Claude

AVEC Georges Claude (décédé le 23 Mai) vient de disparaître un des derniers pionniers, inventeurs, ingénieurs, savants, qui ont permis la révolution industrielle qui précéda la Première Guerre Mondiale. Ingénieur débutant, Georges Claude s'intéresse à l'acétylène, rendu accessible par la fabrication au four électrique du carbure de calcium ; en 1896, il crée l'industrie de l'acétylène dissous et permet l'essor de la soudure autogène, du découpage au chalumeau : les techniques de la construction mécanique sont immédiatement transformées.

Claude se préoccupe alors du prix de revient de l'oxygène, non pas tant pour abaisser le prix de la soudure au chalumeau que pour son application à la production des hautes températures. Avant la fin du siècle dernier, il envisage la possibilité de fabriquer le carbure de calcium dans un four à charbon soufflé à l'oxygène ! Ses efforts sont couronnés de succès et la détente avec travail extérieur, qu'il industrialise dès 1902, est universellement utilisée. En 1910, il démontre dans les aciéries belges d'Ougrée la possibilité d'économies substantielles en sidérurgie par l'emploi de l'oxygène. Depuis la fin de la Deuxième Guerre Mondiale, ses prévisions ont été très largement justifiées ; l'avenir montrera, nous en sommes convaincus, que la production du carbure de calcium au four soufflé à l'oxygène n'était pas davantage une utopie.

Claude s'intéresse également aux gaz rares de l'air et réalise la production industrielle de l'argon, du néon, du krypton et du xénon. L'éclairage à incandescence s'en trouve transformé et ces travaux ont conduit à l'éclairage par fluorescence dont nous jouissons maintenant.

Au cours de la Première Guerre Mondiale, Georges Claude s'attaque à la synthèse de l'ammoniaque ; aux 250 atmosphères du Prof. F. Haber, il oppose audacieusement les 1,000 atmosphères auxquelles il prétend travailler, et il y réussit. Son procédé est encore employé et l'on peut dire que les procédés Casale ou Fauser ne sont qu'un compromis raisonnable entre les pressions déjà courantes du temps de Haber et les hyperpressions dont Claude a rendu possible l'emploi.

Du domaine des hyperpressions, son imagination créatrice entraine Georges Claude vers l'emploi des pressions réduites. Passionné des grands problèmes qui dominent l'avenir du monde, il voit là un moyen d'utiliser l'inépuisable réservoir d'énergie que constituent les océans par la différence de température entre les couches superficielles et les couches profondes de l'eau. Dans une première installation, il réussit à entrainer une dynamo de 60 kW. par une turbine mue par de la vapeur à faible pression qui se condense au contact d'eau froide. La différence de température n'est que de 20° C. ; l'eau de la Meuse lui sert de source froide, et il prend comme source chaude cette même eau servant à refroidir les tuyères du haut-fourneau.

Georges Claude s'engage alors tout seul dans l'expérimentation industrielle. A Cuba, après trois tentatives, il immerge dans le fond de l'océan un tube de deux mètres de diamètre et de plus de deux mille mètres de long. Il réussit à faire fonctionner son turbogénérateur et peut éclairer la station expérimentale qu'il a construite de ses deniers. Une nouvelle tentative pour atteindre une échelle industrielle (2,000 kW.) échoue par suite de l'hostilité des éléments, déchainés contre un inventeur génial. La