

always open to them. His clear logical exposition and the slow tempo of his speech, whether in lecture or conversation, made misunderstanding impossible, and will be as well remembered as his rapid pace as a leader of field expeditions and his speed when driving. Despite his undoubtedly important original contributions to science, it will probably be as a teacher that most people will think of him. His teaching career, covering some forty years, belonged in the main to a period when mechanical aids were few and buildings and general equipment inadequate. In such circumstances the personality of the teacher was all in all and Prof. Hickling's innumerable past students, many of them now famous themselves, will bear witness to his pre-eminence in this respect.

His first wife (Gertrude Hermine Geiler), whom he married in 1910 and who died in 1952, was herself a medical doctor of distinction and a pioneer in the nursery-school movement, and she co-operated loyally with him. Together they built up a tradition of friendliness, with which, as with that of disinterested scholarship, the name of Hickling will always be associated. S. I. TOMKIEFF

Dr. W. C. F. Shepherd

WILFRED CHARLES FURNESS SHEPHERD, deputy director of the Safety in Mines Research Establishment, Sheffield, died suddenly at his home on July 19, in his fifty-second year. He had just returned from Germany after attending an International Conference of Directors of Safety in Mines Research at Dortmund.

From Manchester Grammar School, in 1919, Shepherd joined the staff of the late Prof. R. V. Wheeler at the Home Office Experimental Station, Eskmeals, Cumberland, in research on means of minimizing risks of ignition or propagation of explosions of firedamp or coal dust in mines, and devoted the whole of his working life to this purpose. He became well known in all the mining countries of the world for his research on explosives; the much greater safety of mining explosives in use in coal mining to-day in comparison with thirty years ago is an achievement of research teams of which Shepherd became a leading figure.

In his early years he was occupied with the ignition of methane by hot wires and the photographic study of movement of flame in gaseous mixtures in tubes, work related to the safety of electric and flame safety-lamps; but he soon joined the section, directed by the late W. Payman, engaged in investigations of the ignition of firedamp by mining explosives. Payman was applying schlieren photography to the study of the part played by pressure and shock waves in the ignition process and, in 1929, Shepherd was asked, under an arrangement for the exchange of staff, to work in the laboratories of the United States Bureau of Mines. Here he made his first friends among overseas research workers, with whom he maintained an active correspondence for the rest of his life. His year and a half's study of the ignition of firedamp by explosives, by the schlieren method, was published in a Bureau Bulletin in 1932. On his return, he continued work on this subject; many of his findings were of fundamental interest. He published two papers in the *Proceedings of the Royal Society*. A notable contribution was the demonstration of quasi-detonation in methane-air mixtures under the influence of projected hot particles. He studied the ignition of

gaseous mixtures by impulsive pressures produced by the bursting of diaphragms in shock tubes. He showed that surprisingly low pressures were sufficient to ignite mixtures of certain inflammable gases and oxygen and that ignition could even ensue from rapid expansion, that is when, for example, a methane-oxygen mixture under pressure in a tube was released into open air by the bursting of a restraining diaphragm at one end. This novel expansion-ignition phenomenon was the subject of a paper written shortly before his death. It was during this pre-war period that, with D. W. Woodhead, also in Payman's group, he developed the instrument which became known as the Buxton rotating-mirror camera.

During the war years Payman and his colleagues turned to work, under the Ministry of Supply, with military explosives, on problems relating to the detonation of shaped charges and the fragmentation of projectiles. The years 1940-45 were a period of intense activity and provided valuable experience in the development and application of new techniques. Shepherd's inventive and organizing ability assisted the team in making important contributions to armament design. Most of the work necessarily remains unpublished. The work for the Ministry of Supply continued after the War, and at Payman's death in 1946 Shepherd took over the direction of the team, and, at the same time, guided the re-establishment of the team devoted to research on coal-mining explosives. He initiated a long-term research programme and, as a more immediate practical contribution, in close collaboration with the explosives industry, he fostered the development of 'equivalent to sheathed' mining explosives in place of the sheathed explosives which were falling short of the hoped-for standard of safety. He published with H. C. Grimshaw a number of papers on these new explosives that, before his death, were meeting a third of the United Kingdom requirements.

From 1947 the responsibility for mine safety research was assumed by the Ministry of Fuel and Power, and the research of the Safety in Mines Research Establishment was expanded. Shepherd was promoted first senior principal scientific officer and then deputy chief scientific officer and became deputy director of the Establishment. He retained his interest in explosives research, and in recent years assisted in initiating research on quite new methods of blasting, convinced that the problems of mining would not be solved by research directed solely to the study of the explosives. Prompted by the disastrous fire at Creswell Colliery, he directed the formation of a new team for fire research to work on mining problems in collaboration with the Joint Fire Research Organization of the Department of Scientific and Industrial Research, and he published two authoritative papers on fire prevention. At the time of his death he was engaged in planning an important new programme of research on flame propagation and explosion prevention for the Factory Department of the Ministry of Labour and the Department of Scientific and Industrial Research.

His sudden death at the height of his powers is a serious loss to British mining research. Shepherd, though always modest and unassuming, was a man of much strength of character, who never spared himself throughout his working life. Many men in the world of mining both in the United Kingdom and in laboratories abroad will mourn his death. He leaves a widow and one daughter. H. C. GRIMSHAW