gas up to the $CO/CO_2$ equilibrium ratio at the particular temperature involved. Such conditions comprise all that are likely to be met with (as regards ore reduction) in the blast-furnace between the temperature limits referred to.

The results obtained show, *inter alia*, that (as might be expected) at each temperature the velocity of ore reduction diminishes progressively as the reduction proceeds and the carbon dioxide content of the gases increases. Such rate of decrease is not, however, uniform with the state of deoxidation of the ore, being generally smallest when the ore is about half reduced. While an increase in the gas velocity from 4 ft. to 16 ft. per second invariably resulted in an increase in the relative reduction velocity at all the temperatures investigated, a further increase in the gas speed to 48 ft. per second reduced the ore reduction velocity at 650° but increased it at 850°.

The results have also shown conclusively that there are three definite stages in the ore reduction, corresponding with the three known oxides of iron, namely, $Fe_2O_3$, $Fe_3O_4$ and FeO.

The main interest of the research lies, however, in the discovery that, as regards the third stage (that is, $FeO \rightarrow Fe$)—which comprises two thirds of the whole deoxidation—the rate of ore reduction for corresponding speeds and compositions of the gas throughout the range 650°–1000° C. in the furnace is at a decided minimum between 750° and 800°–850° C. This applies to all the three gas speeds examined, and points to there being a change in the mechanism of ore reduction by carbonic oxide round about 750°. Thus, the relative velocities at 50 per cent ore reduction, for each of the three gas speeds in question, varied as in the accompanying table with the temperature and $CO_2$-content of a 'blast-furnace gas' originally containing 33·4 per cent of carbonic oxide and 66·6 per cent of nitrogen (that is, $CO+2N_2$).

Relative Ore Reduction Velocities by Blast Furnace Gas
(in terms of units of oxygen removed per unit time)

| Temp. °C. | | 650 | | | 750 | | | 850 | | | 1,000 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Gas velocity ft. per sec. | | 4 | 16 | 48 | 4 | 16 | 48 | 4 | 16 | 48 | 4 | 16 | 48 |
| Percentage $CO_2$ in the Gas | 2·5 | 3·2 | 3·5 | 1·75 | 1·2 | 1·4 | 1·05 | 1·85 | 2·0 | 4·55 | 11·8 | 13·5 | 12·0 |
| | 5·0 | 2·1 | 2·6 | 1·15 | 0·9 | 0·95 | 0·7 | 1·1 | 1·3 | 4·2 | 7·0 | 11·1 | 7·4 |

This last-named discovery would seem to be of great importance to blast-furnace practice, especially as 750° is the temperature at which the strongly endothermic decomposition of any limestone ($CaCO_3 = CaO + CO_2 - 42{\cdot}5$ k. cal.) in the burden presumably would be beginning to affect the furnace conditions, and therefore the 750°–850° zone may be of considerable extent in the furnace. Moreover, since the research has also shown it to be that in which ore reduction by any impregnated carbon becomes vigorous, its precise location in the furnace would now seem to be an important matter. Indeed it is clear that if the industry is to reap full benefit from the research, a systematic exploration of the temperature, composition of gas, and ore reduction conditions in blast-furnaces smelting typical ores has now become imperative.

This consideration has so strongly forced itself upon the British Iron and Steel Federation that some months ago a sub-committee was set up, with Prof. Bone as chairman, to consider whether (and if so, what) steps can be taken with a view of organising, and afterwards carrying out, systematic investigations on some typical British blast-furnace plants, and to correlate the results so obtained with those of the laboratory research since its inception.

The sub-committee, having completed its preliminary survey of the matter, has unanimously reported that such an investigation on typical blast-furnace plants is both practicable and highly desirable. Also, certain blast-furnace proprietors and managers who have been approached on the subject have expressed their approval of, and willingness to co-operate actively in, the project, and an experimental trial carried out in December last on a blast-furnace at Park Gate Works, Rotherham, by Mr. F. Clements and his staff, has proved its practicability. So that not only does the time seem ripe, but also the atmosphere is favourable, for putting it into operation, and steps are being taken accordingly. Thus there is now every prospect that the work on the chemical phenomena of iron-smelting, begun by Lowthian Bell sixty-five years ago, may be carried to completion in the country of its origin.

## Obituary

### MR. H. GLAUERT, F.R.S.

SCIENCE and aeronautics have suffered a severe loss through the fatal accident to Mr. Hermann Glauert on August 4. Mr. Glauert was walking with his brother and his three children, and stopped to watch the blowing-up of a tree-stump; a large piece of wood, projected nearly 100 yards, struck and killed him instantly.

Born in Sheffield on October 2, 1892, Mr. Glauert was educated at King Edward VII School and Trinity College, Cambridge. He was a Wrangler with distinction in the Mathematical Tripos in 1913: was awarded the Tyson Medal for 'astronomy and related subjects', the Isaac Newton studentship in 'astronomy and physical optics' (1914), and the Rayleigh Prize for mathematics (1915). He joined the staff of the Royal Aircraft Factory at Farnborough in 1916. In

1920 he was elected a fellow of Trinity, continuing to work at Farnborough. He was a fellow of the Royal Aeronautical Society and he was elected a fellow of the Royal Society in 1931. He married, in 1922, Muriel Barker, a Newnham mathematician and one-time colleague at Farnborough: he leaves two sons and one daughter. He had been for some time a principal scientific officer, and last April he succeeded the retiring head of the Aerodynamics Department of the Royal Aircraft Establishment. He had achieved a world-wide reputation in aerodynamical circles.

Glauert combined, with great mathematical knowledge and ability, a fine physical insight and a talent for approximation, which fitted him peculiarly to satisfy the needs of the aeronautical engineer. His knowledge of German, in addition, placed him in a position to follow the work of the German aerodynamical school. The pioneer work of Mr. F. W. Lanchester, given to the world in his "Aerodynamics" in 1908, received too scant attention in Great Britain, but it inspired Dr. Ludwig Prandtl of Gottingen. The work of Dr. Prandtl and his students spread throughout the world after the War. Glauert was quick to appreciate its value and to introduce it to English readers through his translations.

Glauert concentrated mainly on this line of study and made many original contributions to the theory of aerofoils. Perhaps the most important was a rational theory of the airscrew, which adequately fitted experimental observations and provided a sound basis for practical design and for further study. When the autogiro appeared he successfully turned his attention to an aerodynamic analysis. He also followed up the work of Joukowski and Kutta in deriving the flow round an aerofoil by conformal transformation, extending the method to sections with a finite angle at the trailing edge and originating the later series of R.A.F. sections. He deduced the effect of compressibility of the air on the performance of an aerofoil while streamline motion persists.

Glauert's papers published by the Aeronautical Research Committee were numerous, and he contributed also to the *Proceedings of the Royal Society*. His textbook, "The Elements of Aerofoil and Airscrew Theory" (1926), met a real need and has been widely used; he was awarded a medal for it by the Aero Club de France. More recently, he contributed a part to a more ambitious work undertaken by the Guggenheim Fund under the editorship of Prof. W. F. Durand, of Stanford University. But the full measure of his influence is not to be found in his published papers alone: he was a constant guide and source of inspiration to his colleagues, and he had given enough proof of administrative ability to show that he would make a good head of a research department.

Glauert's habits were tidy, punctual, systematic: his style clear and concise. A rapid worker with great power of concentration, he could turn his mind aside and was ever ready to discuss any subject, a quick and tenacious debater; but he was always loath to deal seriously with problems in any branch of which he did not feel himself master. Outside his work he mixed freely and joined with zest in games and social activities. He will be keenly missed by his associates both at work and at play.

## PROF. W. C. CLINTON

WE regret to record the decease of Prof. Wellesley Curram Clinton, who succeeded Sir Ambrose Fleming as Pender professor of electrical engineering in University College, London, in 1926. He had been prevented for the last three months from attending to his University work by illness, which was not considered to be serious at first, but in August it took an unfavourable turn and to the grief of his relatives, friends and colleagues, he died on August 18. He was sixty-three years of age, having been born in London on October 28, 1871, and he received his early scientific education at Finsbury Technical College under Profs. Ayrton and Perry.

Prof. Clinton had been officially connected with University College for forty-one years. He went as assistant to Prof. Fleming in 1893, when the present Engineering Laboratories were opened, and was appointed successively demonstrator in 1894, assistant professor in 1906, sub-dean of the Faculty in 1919 and Dean in 1934, but did not live to take up that last office. He was elected a fellow of the College in 1920 and fellow of the City and Guilds of London Institute in 1933. He was elected a member of the Institution of Electrical Engineers of London in 1912.

From 1893 until 1926 Clinton assisted Sir Ambrose Fleming in the work of the Electrical Engineering Department of University College with the greatest efficiency and devotion to his duties, and a large number of those now eminent in the electrical engineering profession were his students and will remember with great affection his effective teaching and kindly help. His amiable disposition and efficiency in work made him extremely beloved and appreciated, and his loss will be deeply felt as he was to the front in all that concerned the welfare of the College.

In addition to his College work Clinton found time for some scientific research. He made a speciality of photometry. He translated into English a book on that subject by Dr. L. Bloch, and he published a very useful book on "Electric Wiring" in 1902. He was a contributor to a work on "Modern Electrical Engineering" edited by Sir Magnus MacLean. He also wrote papers on the voltage ratios of the inverted-rotary converter (*Proc. Phys. Soc. Lond.*, 1906), on the efficiency of direct current machines by the Hopkinson method, on a comparison of estimated and observed values of illumination in some lighting installations and on some photometric tests of brightness of radioactive materials. He could have done more research work were it not for his entire devotion to his College duties.