at the Admiralty Research Laboratory. A possible application is that once a suitable calibration has been made, the potentials, in sea or land, may serve as a routine method of measuring tidal streams or other water flow.

The gradients are detected by a high-resistance galvanometer the terminals of which are connected to non-polarizing electrodes placed a mile or so apart on the sea bottom, or down wells near the coast. The potential gradients are of the order of 10 millivolts per kilometre. Evidence that the tidal potential gradients and the electric current associated with them are due to the motion of the tidal streams through the earth's magnetic field is provided by the following observations: (1) The potential gradient in the sea is directed approximately at right angles to the direction of water flow. (2) The times of maximum potential gradient coincide with the times of maximum velocity of the tidal stream. (3) The English coast is positive with respect to the French coast when the tidal stream is flowing east. (4) The potential gradient in the land is directed in the opposite sense to the potential gradient in the sea: when the potential of the English coast is positive, the point of highest potential is on the coast and the potential is less at points farther inland or out to sea.

If the moving water in the Channel acts as a tidal dynamo, the electromotive force to be expected can be estimated from the known velocity of the tidal streams and the vertical intensity of the earth's magnetic field. The estimated electromotive force between the English and French coasts at the time of maximum stream is 3 volts, which is about four times as much as the observed potential difference. The reduction can be attributed to the flow of electric current: when the English coast is at a positive potential the current flows northwards through the water, and after spreading outwards and downwards into the land returns in a southward flow below the sea bed, so that the tidal dynamo is short-circuited. In the water the electric current density is estimated to be about 10^{-8} amp. per square centimetre when the tidal streams have their maximum velocity; but in the land, and below the sea bed, the current density is presumably very much less.

If the magnetic field produced by this presumed flow of electric current could be measured, it would give further valuable evidence of the phenomenon; but since the flow of current is solenoidal it can be expected to produce little or no magnetic field on the earth's surface. On the sea bed in the English Channel at a depth of 100 metres, the flow of electric current may produce a tidal variation amounting to ± 10 gamma in the east–west component of magnetic field; but in the land near the coast at a depth of 1,000 metres the variation of magnetic field may amount to less than 1 gamma, since the current density in the land is so much smaller. No observations of this nature have yet been made.

The observation of tidal potential gradients is usually complicated by more rapid and irregular variation of potential gradient due to earth currents associated with magnetic storms. These earth currents are observed in the sea as well as on land, and they tend to be concentrated in estuaries and channels, presumably because these provide preferential paths of low resistivity.

The magnetic fields of these concentrations make important contributions to the vertical magnetic intensity in the neighbouring coastal regions. This possibility was recognized by Van Bemmelen, who made a survey of the character of the sudden commencement of magnetic storms at a large number of observatories, and showed that the sudden changes of vertical intensity are usually of opposite signs at the Greenwich and Paris Observatories, although the two observatories are only 200 miles apart. He suggested that the difference in sign might be due to earth currents induced by the magnetic storm being concentrated in the English Channel between the two observatories.

An example taken from measurements of the east–west potential gradient in the sea off Plymouth for a minor magnetic storm with a sudden commencement at 2240 hr. on August 30, 1946, when the horizontal intensity changed by 65 gamma in an interval of about three minutes, shows that the east–west potential gradient in the sea increased by 60 millivolts per kilometre at the same time. Assuming that such a potential gradient was present in the whole of the English Channel, it can be inferred that a current of about 3,000 amp. was flowing at the time. Such a current flowing fifty miles from the Observatory at Abinger would produce there a vertical magnetic field of 7 gamma, an appreciable part of the 12 gamma which was actually measured.

Although there is some indication that earth currents localized in the English Channel may produce appreciable magnetic changes at Abinger when the period of the change is as long as an hour, the effect of earth currents should be more important in variations of shorter period. Experiments in the narrow channel between Cumbrae and Bute in the Clyde estuary suggest that earth currents in this and neighbouring channels are the main source of fluctuation of magnetic field as far as periods less than 10 min. are concerned; but for longer periods (greater than 30 min.), the direct magnetic effect of the overhead electric currents becomes of increasing importance relative to that of the earth currents. The study of short-period variations in the earth's magnetic field must, therefore, take account of possible secondary effects due to earth currents concentrated in a channel or arm of the sea.

OBITUARIES

Prof. David Enskog

We learn only now, with much regret, of the death on June 1, 1947, of David Enskog, professor of mathematics and mechanics at the Kungliga Tekniska Högskolan, Stockholm, since 1930.

Born in 1887, Enskog was a student at Uppsala from 1906 until 1911, in which year he obtained his licentiate, partly for experimental work on gas diffusion. In the same year he published a short paper on the kinetic theory of gases, which contains a brief mention (the first so far as I know) of the phenomenon which since 1916 has been called thermal diffusion. In 1912 he published another paper dealing with a gas composed of electrons and molecules; H. A. Lorentz had shown that the mean free-path phenomena for such a gas could be accurately calculated; for this case Enskog made the first accurate calculation of the thermal diffusion coefficient.

Enskog sought without success to obtain a travelling studentship to enable him to continue his studies and research; instead he became a schoolmaster, first at Stockholm, and later at Skövde and Gävle. He married in 1913. During the First World War he was exempted from military service on medical grounds. His years of school teaching continued until 1930, with an interlude of nine months in 1922, during which he held a travelling scholarship of the Swedish Academy of Sciences at Göttingen and Munich. During these seventeen years of school teaching, he produced a long series of papers, mainly on gas theory, but also on integral equations, nuclear structure, and radioactivity. His transfer to a university chair seemed rather to bring him new duties than increased leisure, and this, with renewed ill-health, reduced his productivity in his later years, though he continued to think and write on gas theory; one of his last papers was concerned with the absorption of sound in gases and liquids, owing to viscosity and thermal conduction.

Enskog's most distinguished work was done on the kinetic theory of gases; in his 1917 dissertation, and in a more detailed paper of 1921, he extended Boltzmann's work on entropy and the mean free-path phenomena, solving Boltzmann's integro-differential equation for any moderately rare gas constituted of spherically symmetrical molecules. His exposition was not easy, but his work had great mathematical elegance. The results were substantially the same as those that I had published in 1915 and 1916, following Maxwell's line of approach. In a subject so complicated it was advantageous to have the two independent treatments, the close agreement of which helped others to have confidence in the results. This work forms the main subject of "The Mathematical Theory of Non-Uniform Gases", by Prof. T. G. Cowling and myself, in which we expounded the theory on his lines rather than on those I had followed; the book was, therefore, appropriately dedicated to Enskog.

Enskog also did important work, yielding valuable results, on the kinetic theory of dense gases and liquids; his interest in this difficult subject was shown over many years. It seems likely, however, that the line of future progress lies along another path, recently opened up by Prof. Max Born and Dr. H. S. Green.

In 1946 the Royal Swedish Academy of Science bestowed on him its Svante Arrhenius Medal, in well-deserved recognition of the distinction of his contributions to gas theory.

Enskog was a friendly man of engaging simplicity and great modesty. His home life was very happy. He is survived by his wife and children (a son and two daughters) and grandchildren. S. CHAPMAN

Mr. W. H. Pick

WITH the death of William Henry Pick, a principal scientific officer in the Meteorological Office, which occurred on December 26, 1947, the Meteorological Office and the Royal Air Force lose one who combined to an exceptional degree meteorological and educational ability.

Pick was born in 1891 and after graduating in science at the University of London became a teacher. He showed his interest in meteorology first by maintaining with his pupils at Queen Mary's School, Basingstoke, a climatological station sending returns to the Meteorological Office. He joined the Meteorological Section, Royal Engineers, in 1917, and after serving in France was placed in charge of the meteorological detachment with the North Russian forces in 1919; then in 1920 he joined the Meteorological Office. For the next eight years he was meteorological officer at the Royal Air Force College, Cranwell. He wrote for the cadets his book "A Short Course in Meteorology", which soon found appreciation in a much wider circle, edition after edition being called for.

After nearly four years as a senior forecaster at Meteorological Office headquarters, he was meteorological officer at Andover during 1932–38, and in the earlier part of that period was closely and fruitfully associated with twelve special investigations carried out by the R.A.F. into cloud flying with its risks of ice accretion. Advisory duties at H.Q. Bomber Command during 1938–40 were followed, after a short interlude in the Air Ministry, by duties in connexion with the meteorological aspects of smoke screening, first with the Ministry of Home Security and then with H.Q. Anti-Aircraft Command. From early 1945 until a very few days before his untimely end, he was in charge of the meteorological station at South Cerney meeting the requirements of several R.A.F. stations.

Pick wrote numerous papers published by the Meteorological Office or in the *Quarterly Journal of the Royal Meteorological Society* on visibility as affecting aviation, on the forecasting of night minimum temperatures and the persistence of types of pressure distribution. The thesis "The Teaching of Meteorology in Secondary Schools" for which, with his "Short Course", he was awarded the fellowship of the College of Preceptors particularly exemplifies his two main interests. He served on the council of the Royal Meteorological Society during 1931–36.

Pick will be missed by many members of the Royal Air Force, especially his old Cranwell pupils, to whom he had been a wise teacher and friend, and by his colleagues in meteorological circles. He was married in 1944 and leaves a widow.

Mr. John Lister

MR. JOHN LISTER, formerly head of the Mathematical Department, Chelsea Polytechnic, died at Gawsworth, Cheshire, on December 5. Born at Stockport in 1876, he went to the Royal College of Science, London, in 1895, and took his associateship in 1898 with first-class honours in mathematics, physics and chemistry as his main subjects. After two years teaching at West Ham Technical Institute, he was appointed lecturer at Chelsea Polytechnic, where he spent the rest of his teaching career, being eventually head of the Mathematical Department, until his retirement in 1927.

His wide knowledge of cognate subjects gave colour and interest to his teaching of mathematics, and the admirable lucidity of his expositions will be remembered by many generations of Chelsea students.

WE regret to announce the following deaths:

Prof. T. D. A. Cockerell, emeritus professor of zoology, University of Colorado, on January 26, aged eighty-one.

Dr. H. A. Deslandres, For.Mem.R.S., formerly director of the Observatory of Meudon, on January 15, aged ninety-four.

Mr. Orville Wright, a pioneer with his brother, Wilbur Wright, of the aeroplane, on January 30, aged seventy-six.