special short-wave receivers on those ships using the device, have probably accounted for the unpopularity of the system.

(*b*) *Rotating Loops.*—An alternative method of directional transmission is to invert the direction-finder, and set up a closed loop or frame-coil, supplied with oscillatory current from a suitable transmitter. If the loop be rotated uniformly about a vertical axis, then the signal obtained at a distant receiver will vary according to a cosine law, passing through a zero or minimum when the plane of the loop is perpendicular to the direction of transmission. The orientation of the loop at this minimum signal position can most easily be determined by a timing method. A characteristic signal is emitted when the minimum radiation from the loop is in either the north or east direction, and by measuring the time interval between the reception of this signal and the passage of the signal through its minimum intensity, the bearing of a distant receiver from the transmitter can be easily obtained. Other and somewhat more complicated methods of deducing the bearing have been suggested, and consist in imparting to the radiation some characteristic which depends upon the orientation of the loop ; for example, the wave-length may be varied continuously during rotation.

The rotating loop transmitter used with a timing method has been developed to a high degree in Great Britain by the Air Ministry, and its applicability to marine working is now under investigation. The method has considerable attractions, in that it can be operated on the wave-lengths usually employed in ship and aircraft communication, and in merely requiring at the receiving end a suitable watch and the ordinary type of wireless receiver. A further advantage lies in the fact that the directional part of the system is located in a fixed position on the ground, and that the observed bearings are independent of the direction in which the ship or aircraft is pointing, and are almost entirely immune from any disturbing conditions local to the receiver. It is therefore likely that this method will play an important part in the future of navigation wireless.

(*c*) *Course Setters.*—In concluding this survey, brief mention may be made of the so-called wireless course setter. The use of the directional transmitter has considerable advantages for the navigation of aircraft in that it can be installed at the home station, and the aeroplane has then merely to fly on a constant bearing line to arrive at its destination. To assist in this object an arrangement of a pair of loop transmitters was devised some years ago in Germany, the loops being identical and fixed together at some convenient angle. The loops may either be excited alternately at intervals of once a second, or they may be excited together, but each loop is arranged to emit a Morse signal which is complementary to that given by the other.

When the receiver is located on a line bisecting the angle between the loops, both signals will be received of equal intensity and will thus be indistinguishable from each other. On either side of these bisecting lines the signal from one loop will predominate over that from the other. Thus, while such a scheme is only available over definite courses or air routes, it has the advantage over other directional methods in requiring no special apparatus or timing arrangements, and it gives an immediate indication of any departure from the course caused by drift from wind or tide. Such a method has received considerable attention in America, where it is proposed to establish a network of wireless beacons along the main civil aviation routes.

Obituary.

SIR WILLIAM GALLOWAY.

THE death of Sir William Galloway, which occurred at his home in Cardiff on Nov. 2, removes an outstanding figure in the development of scientific coal-mining. Galloway made a number of important contributions to methods of coal-mining, but he will chiefly be remembered as the originator of the theory, now everywhere accepted, that the great explosions which used, in the absence of proper precautions, to sweep through the roads and workings of collieries, are due to the combustion of coal-dust raised into the air.

Galloway was born in 1840, and belonged to a well-known family associated in the west of Scotland with coal-mining and engineering enterprises. After studying at Giessen, and later at University College, London, he became a junior Inspector of Mines, first in Scotland, and afterwards in South Wales. His attention was thus directed to the causes of explosions. He soon saw that the theory then everywhere accepted, that the great explosions are propagated by the combustion of fire-damp, was quite incapable of explaining the actual facts ; and in a series of papers published in the *Proceedings of the Royal Society* between 1875 and 1887, he formulated and supported the coal-dust theory. His conclusions were derived mainly from an analysis of the evidence afforded by actual explosions, and the demonstration from this that fire-damp could not have been present in appreciable proportion along most of the track of each explosion. The rest of his evidence consisted in the results of experiments on the surface in a gallery constructed for the purpose at a South Wales colliery controlled by his friend and countryman, Mr. A. Hood.

At first Galloway was only able to obtain ignition of a coal-dust cloud when about 1 per cent. of fire-damp was present in the air ; but later he succeeded without the addition of fire-damp. The gallery was too short for the development of the extreme violence often displayed in underground explosions, and it was only in the long experimental gallery built in 1905 at Altoft's Colliery under Sir William Garforth's supervision by the Coal

Owners' Association, that a coal-dust explosion was obtained of sufficient violence to blow the gallery to pieces, and hurl masses of the boiler-plate of which it was constructed five hundred feet into the air.

For many years Galloway's conclusions were received with almost universal scepticism. The idea that colliery explosions are simply due to fire-damp was firmly rooted. It was, moreover, known that blasting with ordinary gunpowder was commonly carried out with impunity at working faces, provided that fire-damp was absent, though much coal-dust might be present. Owing to the conflict between his views and those of senior colleagues, he had to resign his position as inspector of mines. Gradually, however, confirmation came from other mining engineers or scientific investigators, and particularly from junior inspectors of mines, among whom the brothers W. N. and J. B. Atkinson and Mr. Henry Hall took a leading part. Meanwhile, Galloway held for many years the chair of mining at University College, Cardiff. He also became a well-known consulting mining engineer, and remained so until his death, retaining his activities and scientific interests to the last.

Galloway never tired of urging the necessity of precautions against coal-dust explosions. He laid most stress on keeping the roads wet, and providing dust-proof underground waggons; but he also pointed out, and proved by experiment, that the dust could be made safe by the addition to it of inert material. The latter precaution, independently initiated and vigorously developed by the late Sir William Garforth, has turned out to be practicable and effective; and our knowledge of the conditions under which coal-dust explosions occur, and what is necessary to prevent them, has advanced rapidly in recent years, a great part of the advance being due to the experiments carried out under Prof. Wheeler's supervision at the Experimental Stations at Eskmeals, and later at Buxton.

The death-rate from colliery explosions in Great Britain has been reduced to about a tenth of what it was when Galloway began his work. No better tribute than this could be paid to the inherent value of that work, since it is the attention which has been paid to the dangers from coal-dust that has brought about the reduction. But even if he had turned out to be wrong about coal-dust, those who knew him would still have loved and respected him for the greatness of his character. J. S. H.

THE memorial address on Prof. O. Wiener delivered by Prof. L. Weickmann before the Academy of Science at Leipzig on July 1 is reproduced in the *Berichte* of the Academy for that date. Otto Wiener, the son of Christian Wiener, professor of mathematics in Karlsruhe, was born on June 15, 1862, and after leaving school became a student in Karlsruhe, Berlin, and Strasbourg in succession. At Strasbourg he was associated with Kundt, and obtained his doctorate in 1887 with a thesis on the measurement of the thickness of the thin metallic films used by Kundt in his work on the passage of light through metals. After acting as assistant in Strasbourg and in Aix-la-Chapelle, Wiener was appointed professor at the latter in 1894, and at Giessen in 1895. After building a new physics institute there, he was appointed to Leipzig in 1899 and built a still larger institute, which was opened in 1905. He had much to do with the establishment of aeronautical and meteorological departments at Leipzig, and more recently was engaged in developing a kinetic ether theory of the universe. He is, however, best known for his optical researches. He died on Jan. 18 last.

News and Views.

ON Tuesday, Nov. 15, M. Paul Painlevé, professor of celestial mechanics at the Sorbonne, and French Minister for War, gave an evening discourse at the Royal Institution before a large audience. M. Painlevé's lecture took the form of a general review of the evolution of scientific conceptions on the structure of matter from the early speculations of Greek philosophers down to the most recent and advanced theories. He pointed out that this problem resides essentially in a change of scale, and put the question as to whether matter would appear continuous or discontinuous if our senses were refined far beyond the range of our most powerful instrument—the famous controversy of *plenum versus vacuum*. In turn, continuity and discontinuity have seemed to prevail as an explanation of matter and of light. The atomic theory, and the corpuscular emission of light on one hand, and on the other hand thermodynamics and the theory of luminous waves, are characteristic of these two tendencies. Turning to the question of the reality of molecules, M. Painlevé referred to the great number of very diverse methods agreeing to a remarkable degree of accuracy in their result as to the number of molecules in a unit weight, and mentioned in this connexion the researches of Prof. Perrin on the Brownian movement. He then dealt with the atomic microcosm, showing that the study of corpuscular radiations forces us to introduce the idea of discontinuity inside the atom and to regard all matter as made up of two final elements only—the electron and the proton. Towards the end of the lecture, M. Painlevé mentioned the difficulties which lie in the way of explaining the luminous spectra emitted by atoms, and expressed the hope that the new mechanics, by associating material corpuscles with these mysterious waves, would ultimately overcome those difficulties. He showed a series of interesting slides illustrating points which he had discussed in his lecture, such as atomic impacts and coloured regions with well-marked outlines indicating differences of molecular thickness in soap films. The audience frequently expressed appreciation of the lecturer's eloquent exposition of his subject.