ation," by C. G. Abbott and F. E. Fowle, Jr. Notes: "Activity in Magnetic Work"; "Personalia." Abstracts and Reviews: W. van Bemmelen on "Registration of Earth-currents at Batavia," by L. Steiner; Cirera et Barcells on "Activité solaire et les perturbations magnétiques," by J. A. Fleming; Meyermann on "Korrektion der Reduktionsconstanten eines magnetischen Theodoliten," by J. A. Fleming. List of Recent Publications.

THE LIQUEFACTION OF HELIUM

INFORMATION communicated by Sir James Dewar to the London *Times* from Professor Kamerlingh Onnes, of Leiden, shows that helium is a liquid having a boiling point of 4.3 degrees absolute, which is not solid when exhausted to a pressure of ten millimeters of mercury, at which pressure the temperature must have been reduced to within three degrees of the absolute zero—*i. e.,* about one fourth of the temperature of hydrogen in corresponding conditions, as that again is about one fourth of the corresponding nitrogen temperature. If we could obtain another similar drop by the discovery of a gas still more volatile than helium we should have a liquid boiling about one degree above the absolute zero. The *Times* also gives a few notes upon the steps by which the liquefaction of helium has been reached. In 1895, by the application of the method of sudden expansion from high compression, Olscevski, starting from the temperature of exhausted air, failed to get any appearance of liquefaction. In 1901, Dewar, in the Bakerian lecture, described his repetition of that experiment, using liquid hydrogen under exhaustion instead of liquid air, again without obtaining any trace of condensation. Reasoning from the analogy of his experiments on the liquefaction of hydrogen, he showed that by regenerative cooling starting from the temperature of liquid hydrogen, we might expect to liquefy a gas whose boiling point might be as low as four or five degrees absolute. In his presidential address to the British Association in the following year he gave reasons for placing the boiling point of helium at that figure, showing at the same time how great are the experimental difficulties of getting within five degrees of absolute zero. In 1905 Olscevski repeated Dewar's experiment of 1901, using higher pressures, and reached the conclusion that the boiling point of helium must be below two degrees absolute, and that after all the gas might be permanent. The same experiment was repeated early in 1908 by Professor Onnes with a much larger quantity of helium than had previously been available, and he at first thought he had obtained solid helium, but found that the appearance was due to impurity in the gas. Dewar again repeated the experiment by circulating helium in a regenerative apparatus, but though he got cooling, he was baffled by the inadequacy of his supply of helium to maintain the cooling process sufficiently long to reach liquefaction. At last, by the experiment of July 10, Professor Onnes has definitely settled the matter. As new and richer sources of helium have been discovered, and its separation has been enormously facilitated by Dewar's charcoal method, it is possible that helium may become sufficiently abundant in cryological laboratories to be used as liquid hydrogen is now used in physical research.

SPECIAL ARTICLES

ELECTROMAGNETIC MASS

THE variations of meaning attached to d'Alembert's principle, that depend upon what we may call the genesis of the terms involved in its expression, has been insisted upon in a previous article.[1] We find a similar double chance open for instructive interpretation in many other equations of theoretical physics, among which we now select that important result in hydrodynamics which may be regarded as furnishing the original suggestion of "electromagnetic mass." For a solid of mass m moving in the line X through an ideal liquid free from boundary conditions, the familiar power equation is

$$Xu = d/dt\left(\tfrac{1}{2}mu^2 + \tfrac{1}{2}m_1u^2\right). \qquad (1)$$

Here X denotes the aggregate of force *external to the system* consisting of m and the

[1] SCIENCE, Vol. XXVII., p. 154.