as the hydro-electric attraction of that part of the vortex system which is left behind in the free air upon that part which is anchored to the wing. The analogy with electromagnetism allows us immediately to write down formulæ for this attraction.

The theory of hydrodynamic actions-at-a-distance, which has hitherto been so absolutely useless from a

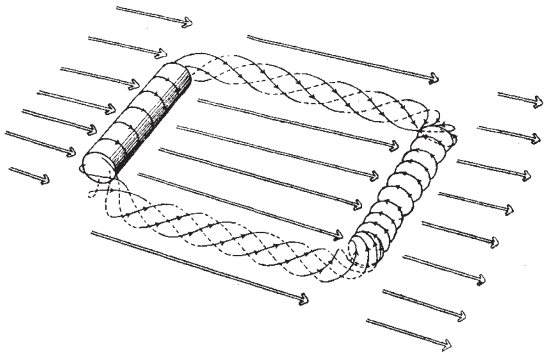

FIG. 4.—Vortex system set up by an aeroplane.

practical point of view, has recently become very practical. It opens up the possibility of applying electromagnetic formulæ to the theory of aeroplanes.

Moreover, it is a short step from the theory of the wing to the theory of the propeller. The fact that its motion is circular instead of translational is of no importance. The force exerted against the propeller blade depends upon the circulation produced round it, and can be calculated by the theory of the hydrodynamic actions-at-a-distance. From the propeller blade the way is not far to the turbine blade. The type of driving force will remain the same whether the driving medium be incompressible water or expanding steam. In the latter medium, effects of expansion will come into play of the kind exemplified by the experiment with the pulsating bodies. But the greater the complications, the more complete is the use which has to be made of the theory of the hydrodynamic actions-at-a-distance.

It is not least interesting from this point of view to consider the transfer of mechanical to electrical energy or vice versa. Let us suppose that at one end of a shaft we have a water or steam turbine, at the other end a dynamo. At the turbine blades the hydrodynamic actions-at-a-distance are in activity, and in the dynamo the equal but opposite electromagnetic actions. We derive both of them by the same formulæ, only with a change of sign when we pass from one set to the other. One set of forces is like a reflected image of the other.

Do we not here behold a deep harmony of Nature at a point where important practical problems are intertwined with ideas of deep theoretical interest? Finally, what does Nature mean by placing us face to face with this wonderful harmony between such different branches of physics as hydrodynamics and electrodynamics? This is a question which may be answered by a future Faraday.

Obituary.

VISCOUNT LONG OF WRAXALL, F.R.S.

LORD LONG of Wraxall, whose death occurred on September 26 at seventy years of age, was well known to British workers in several scientific fields. He will be particularly remembered for the unswerving support which he gave to scientific advisors while president of the Board of Agriculture in 1892–1900, as regards the necessary measures to extirpate rabies from the British Isles. At that time it had been proved beyond doubt that hydrophobia was a specific infective disease which did not originate *de novo*, but could only be introduced into a district or country by being passed on from animal to animal. Acting upon this and other knowledge when president of the Board of Agriculture, Lord Long was responsible for the issuing of muzzling orders for dogs, first for London and then for the whole country. The National Canine Defence League thereupon instituted a public campaign against the muzzle and condemned the measures wisely adopted by the Board. Lord Long, however, had instructed himself thoroughly well in the whole question of rabies, and, with laudable firmness, he resisted the outcry and the repeated assaults of the uninstructed sentimentalists. As a result, he was able to demonstrate that, by the strict carrying-out of muzzling orders, rabies could not only be checked but also reduced eventually to extinction. The eighty thousand "dog-lovers" who petitioned for Lord Long's dismissal from his office at the Board of Agriculture showed themselves to be poor friends of dogs by their action, which many of them must afterwards have regretted. In recognition of his work on behalf of science, Lord Long was elected a fellow of the Royal Society in 1902. He was also an honorary LL.D. of the University of Birmingham.

DR. R. S. WOODWARD.

DR. ROBERT SIMPSON WOODWARD, formerly president of the Carnegie Institution of Washington, died on June 29, aged seventy-four, and the following account of his scientific work is taken from the Journal of the Washington Academy of Sciences. Dr. Woodward was born at Rochester, Michigan, July 21, 1849. Following his education as a civil engineer at the University of Michigan, he served with the U.S. Lake Survey, the Transit of Venus Commission of 1882, the U.S. Geological Survey, and finally the U.S. Coast and Geodetic Survey. Leaving the Federal service in 1893, he became professor of mechanics and mathematical physics at Columbia University, New York City. In 1905 he succeeded the late Daniel Coit Gilman as president of the Carnegie Institution of Washington, then but recently founded by Andrew Carnegie. Dr. Gilman's term of office as its first president had been very short, and the real responsibility for formulating the working plans for the development of a new and comparatively untried form of research institution fell upon Dr. Woodward. Following fifteen years of successful administration in this office he retired from active duty in January 1921. He was president in 1900 of the American Association for the Advancement of Science and had also served as president of the American Mathematical Society, the Washington Academy of Sciences, and the Philosophical Society of Washington. He was a member of the National Academy and other national organisations. Dr. Woodward made notable contributions to mathematical physics and astronomy, especially as applied to geodesy and geophysics.