

northern waters outside the Straits of Gibraltar (50 gm. and more per sq. m.). Hard-bodied animals, Crustacea, corals and star-fishes, which have specialised in the utilisation of inorganic materials, are more or less strongly represented in the Mediterranean, but the soft-bodied animals, Mollusca, are deficient to a remarkable extent. This poverty of the waters and sea bottom of the Mediterranean gives an explanation of the dominant features of the piscine fauna, the scarcity of stationary species, the seasonal abundance of the migratory species, for example, of the herring and mackerel families, and the comparative absence of the gadoid and flatfish families, which form the chief marine food of northern peoples.

We obtain glimpses here and there also of other researches pursued by Prof. Schmidt. For nearly twenty years now he has been carrying on an

intensive study of the races of fishes (eels, gadoids, *Zoarces*, etc.) and the causes of variation. In this pursuit, not content with the mere statement of variations in many thousands of specimens from many places, he has turned to direct experiment. The various theories connected with variation, heredity, natural selection, and the influence of environment have been tested by searching inquiry, and when the resources of the Carlsberg Laboratory proved insufficient for his purpose, he has made the waters round the Danish Islands, where the transitional conditions offer exceptional opportunities, his field of experimentation. These experiments, which fit in so well with his more general investigations, are approaching another milestone in their progress and seem destined to throw light not only on the causes and persistence of variations, but also on the origin of species. H. M. K.

Nikolaus August Otto, 1832-1891

AMONG the names of the hundreds of inventors through whose individual efforts the internal combustion engine has reached its present state of efficiency, that of Nikolaus August Otto will always be associated with the invention of the atmospheric gas engine and with the introduction of the four-stroke or Otto cycle for gas engines, which formed the subject of his German patent of Aug. 4, 1877. Since then, the Otto cycle has been applied to internal combustion engines to an extent little dreamt of by the inventor, and it has proved of such fundamental importance that it may almost be compared with the invention of the separate condenser for the steam engine by Watt about a hundred years earlier. There are, it is true, many internal combustion engines running on the two-stroke cycle, but the vast majority of the millions of engines found in power-houses, factories, ships, motor cars, and aeroplanes to-day work on the four-stroke cycle.

Otto was born on June 14, 1832, at Holzhausen in Nassau, and died on Jan. 26, 1891, at the age of fifty-eight years, at Cologne, where he is buried and where his centenary was commemorated on Tuesday last. The celebration was arranged by the Cologne section of the Verein Deutscher Ingenieure, and the address on the work of Otto, which was broadcast, was given by Dr. A. Langen. To mark the occasion the Newcomen Society sent a chaplet with a suitable inscription, to be placed on Otto's tomb, in the Friedhof Melaten.

Otto's first occupation was that of a commercial traveller, and it was while engaged in business in Cologne that his attention was attracted to the gas engine. Considering it possible to make a gas engine capable of competing successfully with the steam engine, Otto began inventing, and through this was brought into contact with the engineer, Eugen Langen (1833-1895). On March 31, 1864, the two entered into partnership as N. A. Otto and Co.; on April 21, 1866, they patented the vertical atmospheric gas engine with the free piston, and in the

following year exhibited one of their engines at the Paris Exhibition. The fuel consumption of this engine was far less than any of the French engines, and, thanks largely to their countryman, Prof. Franz Reuleaux (1829-1905), one of the jurors of the Exhibition, the work of Otto and Langen was duly recognised.

This proved the turning point in the fortunes of the firm; for, encouraged by Reuleaux, the partners decided in 1869 to erect a factory at Deutz near Cologne, and in 1872 they formed the firm long since known as the Gasmotorenfabrik Deutz A.-G. At the same time, they secured the services of Gottlieb Daimler (1834-1900), the future inventor of the light spirit engine, and with him came Wilhelm Maybach (1846-1929), the future constructor of famous motor-car and aircraft engines. Otto now returned to his earlier experiments with engines working on the four-stroke cycle—a method of operation, it should be remembered, which was described in a pamphlet in 1862 by the Frenchman Alphonse Beau de Rochas. Success was achieved in 1876, the patent secured in 1877, and a four-stroke engine was exhibited at the Paris Exhibition of 1878. With this a new chapter in the history of gas engines began. Their manufacture was taken up by makers in various countries, notably in England by Messrs Crossley Brothers, and Otto gas engines soon became known all over the world.

Like many other persevering pioneers, no sooner had the Deutz firm achieved success than they found themselves drawn into litigation, and in the end the verdict was given against them and their patent declared void. But although it can be clearly shown that many of the ideas incorporated in the Otto engine had been previously thought of by earlier inventors, nothing can detract from the merits of Otto as the first to bring to fruition the valuable plan of operating gas engines on the four-stroke cycle. This alone will always secure for him a place among the greatest pioneers of the internal combustion engine. E. C. S.