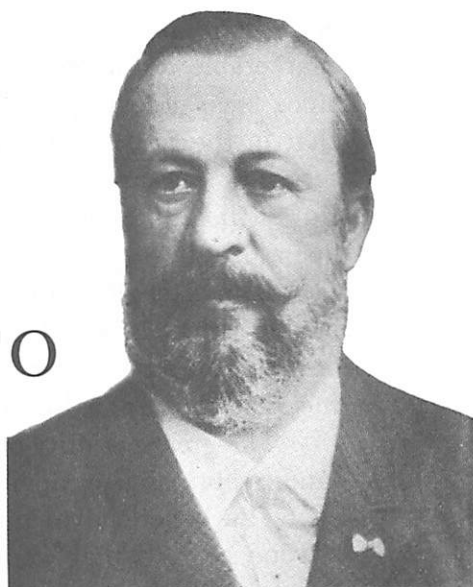


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NIKOLAUS AUGUST OTTO

1832 - 1891



Nikolaus August Otto was the German inventor who, in 1876, built the first four-stroke internal combustion engine, the prototype of the hundreds of millions that have been built since then.

The internal combustion engine is a versatile device: it is used to power motorboats and motorcycles; it has had many industrial applications; and it was the vital requisite for the invention of the airplane. (Until the first jet plane flew, in 1939, virtually all aircraft were powered by internal combustion engines working on the Otto cycle.) However, by far the most important use of the internal combustion engine is to power automobiles.

There had been many attempts to construct automobiles before Otto developed his engine. Some inventors, such as Siegfried Marcus (in 1875), Étienne Lenoir (in 1862), and Nicolas Joseph Cugnot (about 1769), had even succeeded in building models that ran. But lacking a suitable type of engine—one capable of combining low weight with high power—none of those models was practical. However, within fifteen years of the invention of Otto's four-stroke engine, two different inventors,

Karl Benz and Gottlieb Daimler, each constructed practical, marketable automobiles. Various other types of engines have since been used to power automobiles, and it is quite possible that in the future, cars powered by steam, or by electric batteries, or by some other device, will ultimately prove superior. But of the hundreds of millions of cars built in the past century, 99 percent have used the four-stroke internal combustion engine. (The Diesel engine, an ingenious form of internal combustion engine which is used to power many trucks, buses, and ships, employs a four-stroke cycle basically similar to Otto's, but the fuel is admitted at a different stage.)

The great majority of scientific inventions (with the important exceptions of weapons and explosives) are generally conceded to be beneficial to mankind. It is rare, for example, that anyone suggests that we abandon refrigerators or penicillin, or that we seriously restrict their use. The drawbacks of the widespread use of private automobiles, however, are glaringly obvious. They are noisy, they cause air pollution, they consume scarce fuel resources, and each year they cause a ghastly toll of dead and injured persons.

Clearly, we would never consider putting up with the automobile if it did not provide us with enormous advantages as well. Private automobiles are infinitely more flexible than public transportation. Unlike railroads and subway trains, for example, a private automobile will leave whenever you wish, will take you wherever you want to go, and will provide door-to-door service. It is fast, comfortable, and carries luggage easily. By providing us with an unprecedented degree of choice about where we live and how we spend our time, it has considerably increased individual freedom.

Whether all these advantages are worth the price that the automobile exacts from society may be debatable, but no one denies that the automobile has had a major impact on our civilization. In the United States alone there are over 180 million cars in use. Together, they account for approximately three *trillion* passenger miles a year—more than the combined mileage

traveled on foot, in airplanes, in trains, in boats, and by all other forms of transportation.

To accommodate the automobile, we have built acres of parking lots and endless miles of superhighways, altering the whole landscape in the process. In return, the automobile provides us with a mobility scarcely dreamed of by earlier generations. Most car owners now have a vastly larger range of activities and facilities readily available than they could possibly have had without the automobile. It widens our choice of where we work and where we can live. Thanks to the automobile, numerous facilities that previously were only available to urban dwellers are now available to those who live in the suburbs. (This has perhaps been the principal underlying cause of the growth of the suburbs in recent decades and the concomitant decline of the inner cities in the United States.)

Nikolaus August Otto was born in 1832, in the town of Holzhausen, in Germany. His father died when he was an infant. Otto was a good student; however, he dropped out of high school at the age of sixteen to get a job and to gain business experience. For a while, he worked in a grocery store in a small town. Later, he was a clerk in Frankfurt. After that, he became a traveling salesman.

About 1860, Otto heard of the gas engine recently invented by Étienne Lenoir (1822-1900), the first workable internal combustion engine. Otto realized that the Lenoir engine would have many more applications if it could run on liquid fuel, since in that case it would not have to be attached to a gas outlet. Otto soon devised a carburetor; his patent application was denied by the patent office, however, because similar devices had already been invented.

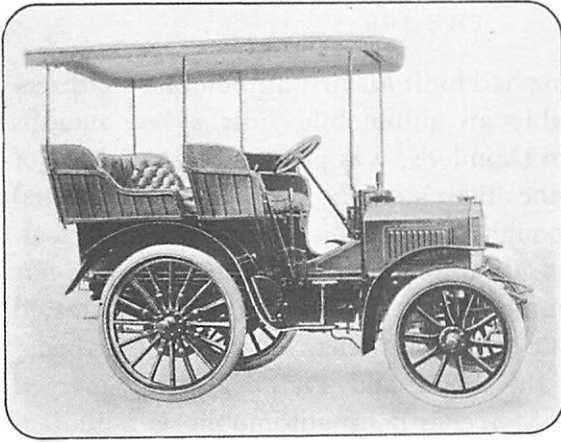
Undiscouraged, Otto devoted his efforts to improving the Lenoir engine. As early as 1861, he hit upon the idea of a basically new type of engine, one operating on a four-stroke cycle (unlike Lenoir's primitive engine which operated on a two-stroke cycle). In January 1862, Otto built a working model of his four-stroke engine. But he ran into difficulties, especially with the

ignition, in making this new engine practical, and soon put it aside. Instead, he developed his "atmospheric engine," an improved two-stroke engine, which ran on gas. He patented it in 1863, and soon found a partner, Eugen Langen, to finance him. They built a small factory, and continued to improve the engine. In 1867, their two-stroke engine won a gold medal at the Paris World's Fair. Thereafter, sales were brisk, and the company's profits soared. In 1872, they hired Gottlieb Daimler, a brilliant engineer with experience in factory management, to help produce their engine.

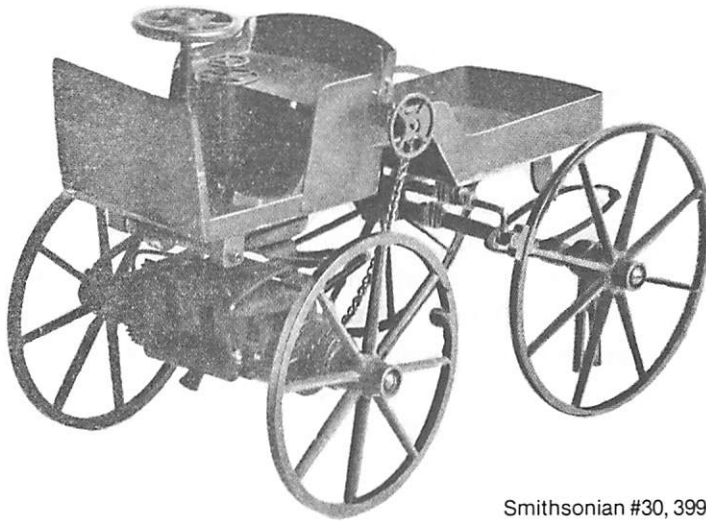
Although profits from the two-stroke engine were good, Otto could not get out of his mind the four-stroke engine that he had conceived originally. He was convinced that a four-stroke engine, which *compressed* the mixture of fuel and air before igniting it, could be much more efficient than any modification of Lenoir's two-stroke engine. In early 1876, Otto finally devised an improved ignition system, and with it was able to construct a practical four-stroke engine. The first such model was built in May 1876, and a patent was granted the following year. The superior efficiency and performance of the four-stroke engine were obvious, and it was an immediate commercial success. Over 30,000 were sold in the next ten years alone, and all versions of the Lenoir engine soon became obsolete.

Otto's German patent on his four-stroke engine was overturned in 1886 in a patent suit. It turned out that a Frenchman, Alphonse Beau de Rochas, had thought of a basically similar device in 1862, and had patented it. (One should not, however, think of Beau de Rochas as an influential figure. His invention was never marketed, and, indeed, he never built a single model. Nor did Otto get the idea of his invention from him.) Despite the loss of the valuable patent, Otto's firm continued to make money. When he died, in 1891, he was prosperous.

Meanwhile, in 1882, Gottlieb Daimler left the firm. He was determined to adapt the Otto engine for vehicular use. By 1883, he had developed a superior ignition system (*not*, however, the one in general use today), which enabled the engine to operate at



Otto's engine was employed by automobile pioneers Gottlieb Daimler and Karl Benz. The first Royal Daimler was a 6-horsepower car supplied to the Prince of Wales.



Smithsonian #30, 399

The original "Benzine Buggy."

700-900 revolutions per minute. (Otto's models had a top speed of 180-200 rpm.) Furthermore, Daimler took pains to construct a very light engine. In 1885, he attached one of his engines to a bicycle, thereby constructing the world's first motorcycle. The following year, Daimler constructed his first four-wheel automobile. It turned out, though, that Karl Benz had beat him

to the punch. Karl Benz had built *his* first automobile—a three-wheeler, but undeniably an automobile—just a few months earlier. Benz's car, like Daimler's, was powered by a version of Otto's four-stroke engine. Benz's engine ran at well under 400 rpm, but that was enough to make his automobile practical. Benz steadily improved his automobile, and within a few years he succeeded in marketing it. Gottlieb Daimler started marketing his cars a bit later than Benz, but he, too, was successful. (Eventually, the Benz and Daimler firms merged together. The famous Mercedes-Benz automobile is manufactured by the resulting firm.)

One more figure in the development of the automobile must be mentioned: the American inventor and industrialist, Henry Ford, who was the first to mass-produce inexpensive automobiles.

The internal combustion engine and the automobile were inventions of staggering importance, and if a single person were entitled to exclusive credit for them he would rank near the top of this list. The principal credit for these inventions must, however, be divided among several men: Lenoir, Otto, Daimler, Benz, and Ford. Of all these men, Otto made the most significant contribution. The Lenoir engine was intrinsically neither powerful nor efficient enough to power automobiles. Otto's engine was. Before 1876, when Otto invented his engine, development of a practical automobile was almost impossible; after 1876, it was virtually inevitable. Nikolaus August Otto is, therefore, one of the true makers of the modern world.