Topic Page: Automobiles

Definition: **automobile 1** from *Merriam-Webster's Collegiate(R) Dictionary*

pronunciation

(1883) **:** automotive

Image from: **A modern car is designed with crumple zones at...** in *Philip's Encyclopedia*

Summary Article: **automobile**
From *The Columbia Encyclopedia*

self-propelled vehicle used for travel on land. The term is commonly applied to a four-wheeled vehicle designed to carry two to six passengers and a limited amount of cargo, as contrasted with a truck, which is designed primarily for the transportation of goods and is constructed with larger and heavier parts, or a bus (or omnibus or coach), which is a large public conveyance designed to carry a large number of passengers and sometimes additionally small amounts of cargo. For operation and technical features of automobiles, differential; fuel injection; ignition; internal-combustion engine; lubrication; muffler; odometer; shock absorber; speedometer; steering system; suspension; tachometer; tire; transmission.

Automobile Propulsion Systems

Reciprocating Internal-Combustion Engines

The modern automobile is usually driven by a water-cooled, piston-type internal-combustion engine, mounted in the front of the vehicle; its power may be transmitted either to the front wheels, to the rear wheels, or to all four wheels. Some automobiles use air-cooled engines, but these are generally less efficient than the liquid-cooled type. In some models the engine is carried just forward of the rear wheels; this arrangement, while wasteful of space, has the advantage of better weight distribution. Although passenger vehicles are usually gasoline fueled, diesel engines (which burn a heavier petroleum oil) are employed both for heavy vehicles, such as trucks and buses, and for a small number of family sedans. Both diesel and gasoline engines generally employ a four-stroke cycle.

The Wankel Engine

For some years, it was hoped that the Wankel engine, a rotary internal-combustion engine developed by Felix Wankel of Germany in 1954, might provide an alternative to the reciprocating internal-combustion engine because of its low exhaust emissions and feasibility for mass production. In this engine a three-sided rotor revolves within an epithrochoidal drum (combustion chamber) in which the free space contracts or expands as the rotor turns. Fuel is inhaled, compressed, and fired by the ignition system. The expanding gas turns the rotor and the spent gas is expelled. The Wankel engine has no valves, pistons, connecting rods, reciprocating parts, or crankshaft. It develops a high horsepower per cubic inch and per pound of engine weight, and it is essentially vibrationless, but its fuel consumption is higher than that of the conventional piston engine.

Alternative Fuels and Engines

Internal-combustion engines consume relatively high amounts of petroleum, and contribute heavily to air pollution; therefore, other types of fuels and nonconventional engines are being studied and developed.

An alternative-fuel vehicle (AFV) is a dedicated flexible-fuel vehicle (one with a common fuel tank designed to run on varying blends of unleaded gasoline with either ethanol or methanol) or a dual-fuel vehicle (one designed to run on a combination of an alternative fuel and a conventional fuel) operating on at least one alternative fuel. An advanced-technology vehicle (ATV) combines a new engine, power train, and drive train system to significantly improve fuel economy. It is estimated that more than a half million alternative-fuel vehicles were in use in the United States in 2002; 50% of these operate on liquefied petroleum gas (LPG, or propane) and almost 25% use compressed natural gas (CNG).

The ideal alternative-fuel engine would burn fuel much more cleanly than conventional gasoline-powered internal-combustion engines and yet still be able to use the existing fuel infrastructure (i.e., gas stations). Compressed natural gas, propane, hydrogen, and alcohol-based substances (gasohol, ethanol, methanol, and other “neat” alcohols) all have their proponents. However, although these fuels burn somewhat cleaner than gasoline, the use of all of them involves trade-offs. For example, because they take up more space per mile driven, these alternatives require larger fuel capacities or shorter distances between refueling stops. In addition, conventional automobiles may require extensive modifications to use alternative fuels; for example, to use gasohol containing more than 17% ethanol, the spark plugs, engine timing, and seals of an automobile must be modified; since 1998, however, many U.S. automobiles have been manufactured with equipment that enables them to run on E85, a mixture of 85% ethanol and 15% gasoline. Fuels derived from plant materials, such as ethanol, are a popular concept because they do not deplete the world's oil reserves; in various locations, “biodiesel” test cars have run on fuel similar to sunflower-seed oil. Similarly, dual-fuel (gasoline-diesel and gasoline-propane) and water-fuel-emulsion cars are being tested.

Alternative propulsion systems are also have been developed or studied. Steam engines, which were once more common than gasoline engines, have been experimented with because they give off fewer noxious emissions; they are, however, less efficient than internal-combustion engines. Battery-powered electric engines, used in some early automobilies and later mainly for local delivery vehicles, are now used in automobiles capable of highway speeds, but they are restricted to shorter trips because of limitations on the storage batteries that power the motors and the time required to recharge the batteries. Electric (and hybrid) automobiles can use regenerative braking, in which the motor operates in reverse and acts as a generator, to help recharge the batteries. A true mass-market all-electric automobile was first sold to consumers in late 2010.

Some engineers worry that widespread adoption of electric cars might actually generate more air pollution, because additional electric power plants would be needed to recharge their batteries. Therefore, design and research work has also intensified on solar batteries, but they are generally not yet powerful enough to power such vehicles. The most promising technology for electric engines is the fuel cell, but fuel cells currently are too expensive for practical applications.

Hybrid vehicles, or hybrid electric vehicles (HEVs), are powered by two or more energy sources, one of which is electricity, to produce a high-miles-per-gallon, low-emission drive. There are two types of HEVs, series and parallel. In a series hybrid, all of the vehicle power is provided from one source. For example, an electric motor drives the vehicle from the battery pack and the internal combustion engine powers a generator that charges the battery. In a parallel hybrid, power is delivered through both paths, both the electric motor and the internal combustion engine powering the vehicle. Thus, the electric motor may help power the vehicle while idling and during acceleration. The internal combustion engine takes over while cruising, powering the drive train and recharging the electric motor's battery. Some hybrids can operate in electric-only mode. Automobiles with gasoline-electric hybrid engines first appeared on the consumer market in 1999; unhampered by the AFV's limitations, sales of these vehicles increased steadily at the beginning of the 21st cent.

Automobiles and the Environment

Pollutants derived from automobile operation have begun to pose environmental problems of considerable magnitude. It has been calculated, for example, that 70% of the carbon monoxide, 45% of the nitrogen oxides, and 34% of the hydrocarbon pollution in the United States can be traced directly to automobile exhausts (see air pollution). In addition, rubber (which wears away from tires), motor oil, brake fluid, and other substances accumulate on roadways and are washed into streams, with effects nearly as serious as those of untreated sewage. A problem also exists in disposing of the automobiles themselves when they are no longer operable.

In an effort to improve the situation, the U.S. government has enacted regulations on the use of the constituents of automobile exhaust gas that are known to cause air pollution. These constituents fall roughly into three categories: hydrocarbons that pass through the engine unburned and escape from the crankcase; carbon monoxide, also a product of incomplete combustion; and nitrogen oxides, which are formed when nitrogen and oxygen are in contact at high temperatures. Besides their own toxic character, hydrocarbons and nitrogen oxides undergo reactions in the presence of sunlight to form noxious smog. Carbon monoxide and hydrocarbons are rather easily controlled by the use of high combustion temperatures, leaner fuel mixtures, and lower compression ratios in engines. Unfortunately, the conditions that produce minimum emission of hydrocarbons tend to raise emission of nitrogen oxides. To some extent this difficulty is solved by adding recycled exhaust gas to the fuel mixture, thus avoiding the oversupply of oxygen that favors formation of nitrogen oxides.

The introduction of catalytic converters in the exhaust system has provided a technique for safely burning off hydrocarbon and carbon-monoxide emissions. The fragility of the catalysts used in these systems required the elimination of lead compounds previously used in gasoline to prevent engine knock. California, which has the most stringent air-pollution laws in the United States, requires further special compounding of gasoline to control emissions, and several states have mandated that ethanol be mixed with gasoline; as with the elimination of lead, measures taken to control air pollution have a negative impact on fuel efficiency. In 2009 the United States adopted more stringent mileage and emission standards (effective in 2012 and based on California's standards), which were designed to produce the first significant increases in vehicle efficiency and decreases in vehicle pollution since the mid-1980s. By the mid-2010s concerns about automobile pollution and global warming had led a number of foreign countries to ban the sale of gasoline- and diesel-powered cars and vans sometime before mid-century.

Automotive Safety

Fatalities due to automobile accidents have stimulated improvements in automotive safety design. The first innovation involves creating a heavy cage around the occupants of the automobile, while the front and rear of the car are constructed of lighter materials designed to absorb impact forces. The second safety system uses seat belts to hold occupants in place. This was largely ineffective until states in the United States began passing laws requiring seat belt use. The third system is the air bag; within a few hundredths of a second after a special sensor detects a collision, an air bag in the steering wheel or dashboard inflates to prevent direct human impact with the wheel, dashboard, or windshield (newer vehicles sometimes include side air bags, to protect occupants from side collisions). Other advances in vehicle safety include the keyless ignition, which makes it impossible for a driver to start a car while under the influence of alcohol (over half of all vehicle fatalities involve at least one driver who has used alcohol) and antilock braking systems, which prevent an automobile's wheels from locking during braking.

Development of the Automobile

The automobile has a long history. The French engineer Nicolas Joseph Cugnot built the first self-propelled vehicle (Paris, 1789), a heavy, three-wheeled, steam-driven carriage with a boiler that projected in front; its speed was c.3 mph (5 kph). In 1801 the British engineer Richard Trevithick also built a three-wheeled, steam-driven car; the engine drove the rear wheels. Development of the automobile was retarded for decades by over-regulation: speed was limited to 4 mph (6.4 kph) and until 1896 a person was required to walk in front of a self-propelled vehicle, carrying a red flag by day and a red lantern by night. The Stanley brothers of Massachusetts, the most well-known American manufacturers of steam-driven autos, produced their Stanley Steamers from 1897 until after World War I.

The development of the automobile was accelerated by the introduction of the internal-combustion engine. Probably the first vehicle of this type was the three-wheeled car built in 1885 by the engineer Karl Benz in Germany. Another German engineer, Gottlieb Daimler, built an improved internal-combustion engine c.1885. The Panhard car, introduced in France by the Daimler company in 1894, had many features of the modern car. In the United States, internal-combustion cars of the horseless buggy type were manufactured in the 1890s by Charles Duryea and J. Frank Duryea, Elwood Haynes, Henry Ford, Ransom E. Olds, and Alexander Winton. Many of the early engines had only one cylinder, with a chain-and-sprocket drive on wooden carriage wheels. The cars generally were open, accommodated two passengers, and were steered by a lever.

The free growth of the automobile industry in the early 20th cent. was threatened by the American inventor George Selden's patent, issued in 1895. Several early manufacturers licensed by Selden formed an association in 1903 and took over the patent in 1907. Henry Ford, the leader of a group of independent manufacturers who refused to acknowledge the patent, was engaged in litigation with Selden and the association from 1903 until 1911, when the U.S. Circuit Court of Appeals ruled that the patent, although valid, covered only the two-cycle engine; most cars, including Ford's, used a four-cycle engine. The mass production of automobiles that followed, and the later creation of highways linking cities to suburbs and region to region, transformed American landscape and society.

Since 2010 there has been an increased focus on developing a practical automobile in which a computerized driving system either greatly aids or completely replaces the human driver. Although the technology for an automated vehicle has been explored since the 1920s, real work on semiautonomous and autonomous vehicles did not progress until the 1980s and the development of microcomputers, and even then the technology was not commercially practical. In the early 21st cent. an increasing number of automobile manufacturers begin including automatic safety equipment that activates when the vehicle's computerized systems sense conditions such as impending vehicle instability or collision and takes measures, such as automated braking, to avoid crashes and passenger injury. Significant advances also have been made in the development of self-driving vehicles, a number of which have been road-tested successfully in public traffic since 2010. In some cases, autonomous driving capabilities have been incorporated into cars that are commercially available.

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