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The history of the gasoline engine at Mercedes-Benz

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- **Unparalleled development of the gasoline engine since the invention of the automobile in 1886**
- **Technological potential far from exhausted**

The four-stroke gasoline engine was the heart of the first modern automobile designed by Gottlieb Daimler and Carl Benz in 1886. Independently of one another, the two pioneers developed small, high-speed engines, based on Nikolaus Otto's four-stroke principle, for the drive system of new automobiles. Since the use of these engines in the Benz patent motor car and Daimler's motor carriage, the four-stroke gasoline engine has experienced unparalleled development.

With their constant innovation, Daimler AG and its predecessor companies have played an important role in the success story of this internal combustion engine for more than 120 years. It was thanks to their tireless work that the single-cylinder power unit of the automobile pioneers became an ultra-modern drive system, especially for passenger cars.

The evolution of the gasoline engine in Mercedes-Benz vehicles is therefore the story of the continuous improvement of numerous details. Even within individual engine series, continuous revision was testament to the pursuit of the perfect engine. Time and again, the engineers increased output and torque on the one hand, and reduced consumption and emissions on the other. This process incorporated both direct results from corporate research and the experience Mercedes-Benz gained from the use of gasoline engines in racing cars.

This history is forever being rewritten, because the Mercedes-Benz engine specialists are not content to sit on their laurels and declare themselves satisfied with one of the high standards that they set for themselves time and again. The current generation of gasoline engines can always be improved further, as has been shown by 125 years of experience. That is how long it has been since Gottlieb Daimler and Wilhelm Maybach resigned from the Deutz engine factory in order to develop their high-speed four-stroke gasoline engine, called the Grandfather Clock because of its appearance. By 1883, the engine had already worked for the first time, and, two years later, Carl Benz's four-stroke engine was also ready for use. Since these engines publicly powered the world's first automobiles in 1886, the evolution of gasoline engine technology has progressed with uninterrupted dynamism. The latest example is the new DIESOTTO engine presented in the Mercedes-Benz F 700 research vehicle at the Frankfurt International Motor Show (IAA), which combines the advantages of the gasoline engine with those of the diesel engine.

The development of the gasoline engine

- **A drive system using controlled explosions**
- **Gasoline as a fuel used at a later stage**
- **Patent for the four-stroke gasoline engine in 1877**

The most important power source during the Industrial Revolution was the steam engine. However, these machines were so large and heavy that they were hardly suitable for powering automobiles. This was due in particular to the spatially separated generation and mechanical use of steam. In categories below the railway locomotive and the traction engine, which was principally used in agriculture, no vehicle could be efficiently operated by a steam engine. Of course, there were different models of steam-powered automobiles and trucks. However, the pursuit of an alternative engine for road vehicles as well as for small-scale trades and industry was to become a separate chapter in the history of the steam engine.

A good solution for the engine needs of small companies and crafts businesses appeared to be the direct-action, coal-gas-operated internal combustion engine. The infrastructure for providing such engines was created in the first third of the nineteenth century: in 1807, the world's first ever gas streetlight was installed in London by way of trial. A few years later, the development of a public coal gas network began in the British capital, and other cities and industrial towns around the world followed suit soon afterwards.

Gas pistols and powder engines

The dream of the internal combustion engine was considerably older than the gas network, however. The Dutch scientist

Christiaan Huygens (1629–1695) had already developed an atmospheric engine that operated with gunpowder. In 1673, Huygens demonstrated his powder engine in public. It achieved its task in that the explosion of the powder produced a partial vacuum in the cylinder, and the piston that was shot upwards by the explosion was then pushed down again by the atmosphere. However, Huygens was unable to produce continuous running of the engine from this single ignition.

The principle of the ignition of gas using an electric spark had also been known for a long time. Amongst the predecessors of the modern gasoline engine was the gas pistol, demonstrated in 1776 by the Italian scientist Alessandro Volta (1745–1827). In order to demonstrate the working of electricity, he ignited a mixture of methane and air in a glass cylinder with the aid of an electric spark. The subsequent explosion forced the stopper out of the cylinder.

Lenoir's gas engine

The world's first truly viable internal combustion engine was the atmospheric two-stroke gas engine by Jean Joseph Etienne Lenoir (1822–1900). The Luxembourg-born inventor developed his double-acting two-stroke engine in 1859. In the Lenoir engine, the non-compressed mixture of coal gas and air was alternately and electrically ignited on both sides of a disk piston. For the ignition, Lenoir used the spark coil developed by Daniel Ruhmkorff. However, the power was produced not by the explosion of the mixture, but by the atmospheric pressure that counteracted the partial vacuum created by combustion.

In January 1860, Lenoir showed his engine in public for the first time, and it was met with great enthusiasm. In the following years, several hundred engines of this type were built, with an output of between 0.25 hp (0.19 kW) and 4 hp (2.9 kW). Owing to the high operating costs compared with a steam engine with the same output, the Lenoir gas engine was favored primarily in those areas where continuous operation was not required – i.e. where the gas engine was able to make use of its advantage of always being quickly ready for use.

Father of the four-stroke gasoline engine: Nikolaus August Otto

The Lenoir engine also inspired the businessman Nikolaus August Otto (1832–1891) and his brother Wilhelm to experiment with engine design. Shortly after the presentation of the French gas engine, the young men, who were originally from the Taunus area of Germany, began their own experiments to try to build a power machine superior to the Lenoir system. A first patent for the provision of fuel by turning ethyl alcohol to gas was denied the two inventors in Prussia in 1861. From a modern perspective, this rejection seems particularly incomprehensible, since, with this concept, the Otto brothers were already envisaging the use of their engine to power vehicles.

Owing to increasing difficulties, Wilhelm Otto soon withdrew from the engine development business. Nikolaus, however, continued the experiments and had his first model engine built in 1861. It became the "*starting point for the four-stroke gas engine*," the inventor reflected in retrospect. In 1862, Otto finally had a four-cylinder trial engine built by Michael Joseph Zons at the mechanical workshop of J. Zons in Cologne. Through the introduction of a new compression stroke during earlier experiments, Otto had worked out the functioning of the four-stroke process, which he now implemented in this model. Every operating cycle of the engine consisted of the following steps: mixture intake, compression, ignition, and discharge of the exhaust gas. This four-stroke engine appears particularly visionary today, since, even then, many of its design-engineering details were similar to those of later engines.

However, the design of the pistons was unusual: each cylinder was equipped with an auxiliary piston. This was intended to minimize the strength of the ignition in that the explosion acted initially on the operating piston which was pressed into the auxiliary piston and compressed the air contained therein. The force thus transmitted was passed on by the auxiliary piston to the crankshaft. The mechanical action was therefore delayed and cushioned by the air. In this way, Otto sought to obtain particularly smooth running. Instead however, the unpredictable action of the auxiliary piston produced very irregular running, and ultimately destroyed the trial engine.

Move away from the direct-acting four-cylinder engine

As a result of these problems, Otto decided to build an atmospheric engine. In an atmospheric internal combustion engine, the explosion did not damage the mechanics because the pressure of the explosion moved the piston upwards. However, a mechanical linkage to the powertrain was produced only at top dead center. After the cooling of the combustion gases in the cylinder, the atmospheric pressure and the weight of the piston generated the power.

The structure again contained an auxiliary piston. When the gas-air mixture was ignited, the explosion initially shot the operating piston upwards, the latter connected via a hollow piston rod to the auxiliary piston. Both pistons were now mechanically coupled. The atmospheric pressure thus acted on both pistons and generated power in that it forced the operating and auxiliary pistons to the floor. At bottom dead center, the pistons were released from one another, and the auxiliary piston rose up again because of the inertia of the flywheel. There, the operating piston contacted it after the next explosion. With his complex arrangement, Nikolaus Otto obtained the intended separation of the drive shaft from the impact of the explosions.

Mechanical engineering company N. A. Otto & Cie.

When Otto had this engine patented, he had hardly any funds left. In this time of financial need, help was provided through contact with the Cologne-based engineer Eugen Langen whom he met in 1864. The two men founded the mechanical engineering company N. A. Otto & Cie., in which Langen was a limited partner. Eugen Langen also contributed to the success of the business as an engineer. He developed the freewheel clutch, which was necessary for a smooth change between the power transmission, during the action of the atmospheric pressure, from the toothed rack of the auxiliary pistons to the driveshaft, and the freewheeling after the ignition of the mixture. In 1866, for the thus amended engine, Otto was finally granted the coveted Prussian patent – his original design had been patented only elsewhere in Europe.

At the World Exhibition in Paris in 1867, Otto's engine was favored over Lenoir's engine and other gas engines. After measuring the gas consumption, the jury even awarded the "Grand Prix" to the German engine because Otto's engine required less than half the gas of other engines. This international approval was the basis for production on a larger scale, and brought the company economic stability. As well as the incorporation of the company, in 1872 the name was changed to Gasmotoren-Fabrik Deutz AG (Deutz Gas Engine Factory). In 1872, Gottlieb Daimler was appointed member of the directorate of Gasmotoren-Fabrik Deutz AG, a company which had emerged from N. A. Otto & Cie. Daimler also brought the design engineer Wilhelm Maybach with him to Otto. In 1875, Maybach was already attempting to convert the atmospheric engine to gasoline operation. His first success was obtained with a wad of rags soaked in gasoline, which he held in front of the engine's gas supply.

Development of the direct-acting four-stroke engine

For Nikolaus Otto, however, the improvement of the engine itself was more urgent than the development of an alternative source of fuel using gasoline, since the design of the atmospheric engine limited the engine's output to a maximum of 3 hp (2.2 kW) as long as the dimensions had to remain in a context that catered to the crafts and small businesses. Hot-air engines by other manufacturers at this time were already reaching up to 8 hp (5.9 kW). In 1876, Otto therefore developed a direct-acting four-stroke gas engine with pre-compression of the charge, which achieved 3 hp (2.2 kW) at 180 rpm. In the process, he adopted the flame ignition and slide valve gear from the atmospheric gas engine. Wilhelm Maybach improved this engine. Parallel to the development of the four-stroke engine, atmospheric gas engines were still being built in Deutz. The last of these engines was purchased by a customer only after 1900.

In 1877, Nikolaus Otto was granted German Reich Patent No. 532

for his engine. In particular, he had the so-called stratified charge patented: he assumed that the smooth and uniform ignition depended on the distribution of mixture concentration in the cylinder. Otto mentioned his revolutionary invention of the four-stroke process, as is still used today, only under Item 4 of the patent. He had not even recognized the significance of this invention himself at the time.

Multi-cylinder engines by Deutz

The basis for Nikolaus Otto's "twin engine" in 1879 was two parallel-mounted four-stroke single-cylinder engines that had ignitions displaced at 360 degrees, and that acted together on a crankshaft. This very smoothly running engine powered in particular dynamos that supplied electrical energy for lighting.

In the same year, Gottlieb Daimler designed the "Deutz compound engine," which operated with two high-pressure cylinders and one low-pressure cylinder. In mechanical terms, this construction corresponded to the connecting of two four-stroke single-cylinder units with one two-stroke single-cylinder. Owing to its inefficiency, the one engine that was delivered to a customer for test purposes was repossessed by Deutz in 1884 as unworkable, and was scrapped in 1925.

Mobility for the gasoline engine

By around 1880, the gasoline engine with flame ignition had become established as a stationary engine for many applications. This internal combustion engine became the basis of modern engine technology. However, its use was still restricted to stationary operation. Then, in 1880, a railway car with a stationary gasoline engine as drive system was created at Hannoversche Maschinenbau AG (Hanomag). The engine, weighing approximately one ton, had also been converted from gas to gasoline operation, and was mounted on a tractor unit for streetcars. For road vehicles, however, the 3-hp (2.2-kW) single-cylinder engine was still too heavy.

In 1884, Nikolaus Otto developed a magneto-electric low-voltage impulse ignition for slow-running stationary engines. This made operation with gasoline simpler, and above all safer, than with spark ignition. Although this ignition device was heavy and expensive, it proved to be very reliable. Because Otto did not patent the contact-breaking ignition, the technology was also used by rival companies; for example, Maybach's racing car built in 1900 also had a low-voltage impulse ignition.

Hanomag pursued an action for annulment against Otto's patent for the first time in 1882. Hanomag's principal argument was the stratified charge of the mixture emphasized by Otto: this alleged prerequisite for the smooth running of a four-stroke engine had, in the meantime, been found to be incorrect. In 1886, the Supreme Court of the German Reich found against Nikolaus Otto, and the patent was cancelled. Other companies could now officially build engines with four- and two-stroke working processes in designs that were previously protected by the Deutz patent. This legal ruling allowed dramatic growth in the engine industry in a short period of time.

Otto's pioneering technological achievements should in no way be underestimated from a modern perspective as a result of the legal ruling of 1886. With his engine, he undoubtedly paved the way for developments such as the Daimler and Benz automobiles, and these two automotive pioneers themselves openly built on Nikolaus Otto's work as they were convinced of the technological merits. In doing so, from the beginning, Benz focused on the efficient integration of the drive system into a road vehicle, while Daimler worked primarily on a universal engine with which he sought to power as many different means of transport as possible. The idea of mobility by means of the four-stroke gasoline engine was realized by both pioneers, although their solutions differed in their details.

Many years later, in 1996, Nikolaus August Otto and Wilhelm Maybach were honored for their achievements in engineering and automotive technology: the two pioneers were inducted into the Automotive Hall of Fame.

Carl Benz and the high-speed four-stroke engine

- **Benz patent motor car: Single-cylinder with electric ignition**
- **Vehicles with horizontally-opposed engines launched in 1897**
- **Four-valve technology in racing cars**

Carl Benz had probably decided in 1876 to build a road vehicle driven by an internal combustion engine. As its drive system, he wanted to use a two-stroke engine, since the four-stroke technology was protected by Nikolaus Otto's patent. In 1879, the engine had been developed to a stage where it ran continuously. The Benz two-stroke units were soon very successful as stationary engines. However, Carl Benz's business partners initially resisted the (costly) development of vehicle drive systems. As a result, Benz left Gasmotoren-Fabrik Mannheim (Mannheim Gas Engine Factory), and together with other partners established the company Benz & Co., Rheinische Gasmotoren-Fabrik (Rhenish Gas Engine Factory) in 1883.

In 1884, Benz took the great leap towards the high-speed engine for an automobile. Now, he wanted to develop a four-stroke engine to be used in his vehicle. Benz started work on the four-stroke engine in fall 1884 in the knowledge that Otto's patent was still in force. This was still the case when his motor car completed the first road tests on the factory premises in 1885. The legal context for Daimler's and Maybach's engine development was similar, although Benz and Daimler were not aware of each other's work. At the time that Carl Benz demonstrated his automobile in public in 1886, Otto's patent was being nullified. Now there could be open competition for the motor car with four-stroke engine.

Single-cylinder with electric ignition

For the engine created in 1885, Carl Benz used electric high-voltage ignition. This hummer ignition theoretically permitted higher engine speed than the hot-tube ignition invented by Daimler. However, this did not yet play a role in the first engines, because they were a long way off exhausting the engine-speed potential. Using a dynamo, Benz obtained the electrical energy for the engines used for the first time in October 1885 in trials in the Benz motor car. Because this early form of alternator did not work in a sufficiently reliable manner under rough road conditions, however, he later decided to install a battery.

In January 1886, Benz filed the patent application for his motor car, and in November of the same year he was granted German Reich Patent No. 37 435 for his three-wheeled “vehicle with gas-fueled engine.” The water-cooled, single-cylinder, four-stroke engine developed 0.75 hp (0.66 kW) at 400 rpm from a displacement of 954 cubic centimeters (bore 90 millimeters x stroke 150 millimeters). The intake of the mixture formed by a surface carburetor was controlled by an automatic slide valve and the outlet by a vertical poppet valve in the cylinder head.

For better cooling, the engine had an open crankcase; together with the ignition and carburetor, it weighed 95.3 kilograms. The weight seemed particularly heavy given the filigree steel-tube construction of the vehicle frame. The single-cylinder engine was mounted horizontally above the rear axle and had a crankshaft running vertically with balance weights and a horizontal flywheel. In his patent motor car, Carl Benz used a differential in a road vehicle for the first time. This allowed reliable steering of the three-wheel vehicle.

Rising production figures

In 1888, Benz presented his motor car at the "Engine and Working Machine Exhibition" in Munich. A sales contract for the car was drawn up, but the deal was not closed. The interest of a potential customer nevertheless showed that there was a market for the new vehicles. The improvement of the engine appeared to be an opportunity to expand the market; the company itself was also encouraging this. Benz & Co. thus commenced production of marine engines in 1890. The innovations implemented in these – in 1893, Benz installed a throttle valve between the carburetor and engine in order to be able to better control the output of the engine – also benefited car engines.

The car engine segment in fact made up only a small part of total production at first. By 1893, Benz had built a total of 1,000 gasoline engines, but from 1886 to 1893 only 69 automobiles had been built. Automobile production then increased significantly from 1894. Parallel to this, the output of the engines also increased from 0.75 hp (0.55 kW) in patent motor car model no. 1 to 3 hp (2.2 kW) from the one-liter engine of the most powerful patent motor car model no. 3.

Innovations for ignition and cooling

In 1893, Benz installed a new ignition system. Instead of the previous solution, in which a primary circuit remained permanently switched on and the battery was accordingly drained quickly, the primary circuit was now switched on only at a total of 70 degrees of crank rotation. That saved energy and also allowed the integration of an ignition retard. Benz arranged this in such a way that it could be operated by means of a lever from the driver's seat. In 1894, the new engine for the Benz Velo, amongst others, was provided with this ignition retard. The engine developed 1.5 hp (1.1 kW) at 450 rpm from a displacement of a little over one liter (110 millimeter bore x 110 millimeter stroke). The Benz Velo is considered to be the world's first series-produced automobile. With its high production figures of approximately 1,200 vehicles, it thus helped raise Benz & Co. (from 1899 onwards Benz & Cie.) to the status of the world's largest automobile manufacturer in the years before 1900.

Besides the ignition, cooling proved to be a problem with the increasing output of the engines. Thus, Benz cooled the 5-hp (3.7-kW) engine of his car with a circulating pump, for example, when the circulation produced by the thermo-siphon action of the water was no longer sufficient. From 1895, the cooling was also supplied with a condenser for coolant recovery, and later there was first the finned-tube radiator (1896), and then the finned radiator (1903).

Enter the horizontally-opposed piston engine

Ten years after the invention of the automobile, the potential of the single-cylinder engines for use in passenger cars appeared to be starting to decline. The search for a more powerful and, at the same time, more sophisticated engine inevitably led to engines with several cylinders. In 1897, Carl Benz, who in 1896 had set up a separate department for motor vehicle production in his Mannheim-based company, addressed the task of designing a two-cylinder engine. The first prototype still had cylinders coupled in parallel, and had similarities with the later in-line engines. However, the "twin engine" was initially only a design, and Benz instead pursued an alternative concept.

He developed a two-cylinder engine with horizontal cylinders, whose pistons working in opposite directions acted on a common crankshaft and provided good balancing of masses. Benz called this engine, which is known today as a horizontally-opposed piston engine, the "contra engine," owing to the opposing action of the pistons. A first 4.2-liter variant was installed in buses as early as 1898. However, the more matured 1.7-liter and 2.7-liter engines were eventually launched in 1899 with outputs of 5 hp (4 kW) and 8 hp (5.9 kW), respectively, in the Benz Dos-à-Dos model.

The contra engine provided many advantages over in-line engines. In particular, the cylinders offset by 180 degrees balanced the distribution of masses very well, because their power strokes in opposing spatial alignment took place in an offset manner such that the moments of the power stroke and intake stroke, and of the exhaust stroke and compression stroke, were offset by one another. This movement of the pistons was possible thanks to a double-offset crankshaft. Because of this double offset, the two cylinders were arranged slightly displaced relative to one another in the engine frame, which was open at the top. This construction also allowed a compact and flat design of the horizontally-opposed piston engine.

The output of the contra engine increased continuously after its launch in 1899. While the 5-hp (3.7-kW) engine of the Dos-à-Dos did not change initially, the larger variant with 2.7-liter displacement initially developed 8 hp (5.9 kW) in 1899, then 9 hp (6.6 kW) in 1900, and finally 10 hp (7.4 kW) in 1901. The top-of-the-line engine among the production engines was the 3.7-liter engine with 20 hp (14.7 kW). Benz also used the horizontally-opposed piston engine in racing cars. The final stage of evolution for the Mannheim racing cars with a contra engine of 1900 likewise developed 20 hp (14.7 kW) – a four-cylinder horizontally-opposed piston engine with 5.4-liter displacement.

Two- and four-cylinder in-line engines

The era of the contra engine at Benz came to an end in 1902. The twin engine and an in-line four-cylinder based on this were now installed in the new Parsifal model from the Mannheim brand. The Parsifal model presented on October 3, 1902 at the motor show in Hamburg had an engine and propeller shaft installed at the front. Benz & Cie. thus finally completed its move away from the rear-mounted engine and belt drive. The presentation took place in December at the Paris motor show, before an international audience.

The two-cylinder engines were equipped with spray-nozzle carburetors, automatic intake valves, side-mounted upright exhaust valves and a lateral camshaft. The long-stroke engines had displacements of 1.5 liter (8/10 hp Benz Parsifal) to 2.3 liter (12/14 hp Benz Parsifal). The two-cylinder model range was enhanced in the spring of 1903 with the first four-cylinder production car by Benz. Unlike the three other variants, the 16/20 hp Benz Parsifal was provided with chain drive. In the same year, Benz presented the 35 hp Parsifal with a four-cylinder engine and a displacement of 5.9 liter as the top-of-the-line-model in this model series. As an entry-level variant, the eight-hp Parsifal with a one-liter single-cylinder engine completed the range.

Four-valve technology for Benz racing cars

Benz & Cie. continued to develop four-valve technology. The generation of Benz cars after the Parsifal had engines with dual ignition, side-mounted upright valves in a T-arrangement and spray-nozzle carburetors. The models shown in 1905 ranged from the 18 hp Benz with 3.2 liter displacement and 18 hp (13 kW) at

1400 rpm to the 35/40 hp Benz with 5.9 liter displacement, which developed its maximum output of 35 to 40 hp (26 kW to 29 kW) at 1350 rpm.

In this period, the two variants of a special touring car that were produced for the 1910 Prinz-Heinrich-Fahrt (Prince Heinrich Rally) represented an exception amongst Benz vehicles: in a first for Benz, these engines were fitted with four valves per cylinder. Both the
5.8-liter engine (80 hp/59 kW at 2500 rpm) and the 7.3-liter engine (100 hp/74 kW at 2500 rpm) had four overhead valves per cylinder in a V-shape arrangement. The intake and exhaust valves were driven by means of two lateral camshafts. Despite the innovative technology, none of the Benz vehicles reached one of the top three positions in the competition hosted by the Prussian prince. The most successful Benz driver was Fritz Erle, who, with an 80 hp (59 kW) special touring car, reached fifth place.

A four-cylinder engine also powered the 200 hp Benz, the record car popularly known as the Lightning Benz. The engine, weighing 407 kilograms, developed 200 hp (147 kW) at 1600 rpm. In a record attempt on the Brooklands racetrack, Fritz Erle, driving the Lightning Benz, exceeded the 200 km/h mark for the first time in 1909. Other records followed, and for several years the car was the fastest vehicle in the world. The 21.5-liter engine had the largest displacement ever used by Mercedes-Benz and its predecessor brands in a racing or record car. Larger displacements were found only in experimental and record cars equipped with four-stroke gasoline aircraft engines, for example the 92/160 hp Mercedes with a Daimler airship engine of 1917 (in-line eight-cylinder, 24-liter displacement, 160 hp/118 kW) and, in particular, the Mercedes-Benz T80 record car of 1939, whose DB 602 RS Spezial V12 aircraft engine developed 3500 hp (2574 kW) from a 44.5-liter displacement.

Six-cylinder in-line and aircraft engines

Benz & Cie. also built aircraft engines based on the Otto cycle: these included the 1912 four-cylinder Benz FX aircraft engine designed by Arthur Berger. In 1913, a Benz FX 9.6-liter four-cylinder engine with a rated output of 105 hp (77 kW) won the Emperor's prize for the best German aircraft engine. The third place in the competition, too, went to Benz & Cie. In the following year, Benz built the Bz DV model – Germany's first V12 aircraft engine. The engine, weighing 425 kilograms and developing 250 hp (184 kW) from a 20.3-liter displacement, was not put into operation, however. By contrast, in 1915, the first large twin-engined AEG airplane was equipped with Benz G-IV six-cylinder engines of the Bz II model, with an output of 150 hp (110 kW) each.

The six-cylinder design also found its way into Benz automobiles in 1914: the 21/50 hp Benz model was the first passenger car from the Mannheim brand to have a six-cylinder in-line engine. The engine had cylinders arranged in pairs and a 5.3-liter displacement, from which it developed an output of 50 hp (37 kW) at 1650 rpm. A 6.5-liter engine with 65 hp (48 kW) output at 1650 rpm later followed the same principle. After the end of the First World War, the first new six-cylinder car produced by Benz was the 27/70 hp model with seven-liter displacement, an output of 70 hp (51 kW) at 1550 rpm, and dual magneto ignition. Before the merger with Daimler-Motoren-Gesellschaft in 1926, Benz developed another two six-cylinder engines. In 1921, a six-cylinder in-line with two sets of three cylinders each was produced, and in 1923 a six-cylinder in-line engine with a one-piece engine block followed.

Gottlieb Daimler, Wilhelm Maybach and the "Grandfather Clock"

- **Groundbreaking inventions allow greater output and reliability**
- **First tests in the Riding Car and motor carriage**
- **1897: The first road vehicles with four-cylinder engines**

Following differences of opinion with Nikolaus Otto, Gottlieb Daimler and Wilhelm Maybach resigned from Gasmotoren-Fabrik Deutz on June 30, 1882. In the summer house of Gottlieb Daimler's villa in Cannstatt, the two men worked on a high-speed and lightweight four-stroke engine. Daimler and Maybach realized this engine the following year. The engine developed approximately 0.25 hp (0.18 kW) at 600 rpm. The first tests were undertaken even without cooling, and with gas operation. Gradually, the inventers progressed towards the modern engine, which was not fully operational until 1884. Because of its shape, the engine was called the Grandfather Clock.

On December 16, 1883, Gottlieb Daimler sought patent protection initially for the "gas engine with hot-tube ignition" and one week later for the "regulation of the speed of the engine through control of the exhaust valve" (curved groove control). This intermittent control was regulated by centrifugal force: a rotating tongue in the curved groove deflected the valve control linkage in the event of excessive engine speed in such a way that the exhaust valve no longer opened. The intake valve of the new engine was still automatically controlled, as it was in Otto's version: it was opened by the atmospheric pressure when the piston started the intake stroke. Both patents, granted on August 4 and 27, 1884 as German Reich Patent Nos. 28 022 and 28 243, respectively, formed the basis for the first high-speed, four-stroke internal combustion engine.

Carburetors and hot-tube ignition

From the outset, Daimler and Maybach focused on gasoline operation of the engine. At Deutz in 1875, Maybach had already gained much experience in the preparation of gasoline-air mixtures. Gas was not actually produced in the carburetor, but rather a fine mist of fuel droplets. The first Daimler engines were equipped with a float-type carburetor designed by Maybach. Daimler retained this technology until 1893 when the spray-nozzle carburetor was introduced. The visionary nature of Wilhelm Maybach's engine design was already clear in a remark from 1884: even at this early stage, Maybach wanted to produce an intake manifold injection system.

The principle of the high-speed gasoline engine for vehicles based on Otto's four-stroke principle was already in evidence in 1884 in the Grandfather Clock. The engine with hot-tube ignition, surface carburetor, and air overloading via a valve in the piston crown developed an output of one hp (0.74 kW) at 600 rpm. Such high engine speeds became possible only for the gasoline engine, thanks to the uncontrolled hot-tube ignition with an open hot tube, since this technology allowed an increase in the engine speed by a factor of five compared with open-flame ignition in the gas engine.

Initially, Daimler planned to use the hot tube only for starting. However, because the compression heat in the cylinder was not sufficient, to ignite the mixture, even in the case of a warmed-up engine, the hot tube was kept red-hot by means of a burner during the entire driving time. Daimler later reflected on the development of this ignition design: "*It was a long road requiring countless tests and the untiring systematic work of the practically experienced engineer, so as not to give up […] in spite of the initially altogether discouraging results of these tests, […] until […] the certainty of the practicability of my uncontrolled ignition had been established and the goal had been achieved*."

The world's first motorcycle

In 1885, Daimler and Maybach fitted a scaled-down version of the Grandfather Clock into a wooden two-wheeler, the Riding Car. In this car, the engine developed 0.5 hp (0.37 kW) at 700 rpm. With this drive system, the design engineers had proven their claims about lightweight construction and miniaturization for a motor vehicle in an impressive manner. Of course, Daimler and Maybach did not have to start from scratch in this regard, since incorporated in the development of the engine was the experience that Maybach had gained when building model engines for Deutz.

In April 1885, Gottlieb Daimler filed a patent application for an engine with a vertical cylinder, which was developed from the experimental horizontal engine of 1883. The engine, protected under the German Reich Patent No. 34 926, had a groundbreaking new design, in which the crank assembly and flywheel were, for the first time, encased in an oil- and dust-tight crankcase.

In August 1885, Daimler then patented the Riding Car. Daimler's younger son Adolf undertook the maiden journey of this, the world's first motorcycle, from Cannstatt to Untertürkheim. The Riding Car achieved speeds of up to 12 km/h, but ride comfort was very poor. Nevertheless, Daimler and Maybach proved that a road-going vehicle, freely controllable by a human being, could be operated with an internal combustion engine that obtained its power from gasoline.

For his first motor car in 1886, Daimler installed an engine in a coach frame. In the first road tests, an air-cooled 0.5-hp (0.37-kW) engine still served as the drive system. The final engine was a single-cylinder four-stroke engine that had a 70-millimeter bore and a 120-millimeter stroke. With the resulting 462-cubic-centimeter displacement, it developed 1.1 hp (0.81 kW) at 650 rpm, while the maximum engine speed was 900 rpm. The engine had a closed crankcase, overhead intake valves, and vertical tappet-controlled exhaust valves, the hot-tube ignition based on the Daimler patent no. 28 022 of 1883, and a surface carburetor based on Maybach's float-type carburetor system. The engine weighed only 40 kilograms; the engine developed independently by Carl Benz at the same time was more than twice as heavy. This lightweight design was possible thanks to the filigree construction: even the Daimler engine used in the Riding Car had thinner walls than had been obtained until then, and was correspondingly light. The case was cast in the bell foundry and fire-extinguisher factory of Heinrich Kurtz in Stuttgart – this factory was better equipped than other foundries to deal with the precise dimensions required.

Gasoline engine for automobiles and boats

As a result of the continued public criticism of the use of highly inflammable benzene as fuel, Daimler called his engine a "petrol engine." This name was intended to evoke petroleum, which people had greater trust in. There was less fear regarding ships that were operated with benzene. Accordingly, Daimler was soon equipping motorboats with his single-cylinder engine. In October 1886, he filed a patent application for a marine engine, and in

1887 was granted German Reich Patent No. 39 367.

At the same time, the first media were recognizing the potential of the new drive system. Thus, in 1887, the United States magazine *The West* had much praise for Daimler's motor carriage. The text in particular portrayed the engine as an outstanding engineering achievement: "*In a car equipped with this driving power, it would replace the power of horses, while in a ship it would replace the steam engine. Its inestimable value lies in the fact that, wherever steam, electricity or gas had to be provided until now to generate power, such a simple and inexpensive engine without additional machinery or requirements could be used to satisfy the least as well as the greatest of demands*."

Daimler's V-engine

Daimler and Maybach were also looking for a solution for the multi-cylinder gasoline engine to improve power output. The result was the world's first two-cylinder V-engine, which in 1889 was installed in the wire wheel car. The engine, developed in 1888, allowed Daimler to reduce the specific engine weight from 80 kilograms to 36 kilograms per hp. In addition to the wire wheel car, the V-engine was used in boats and railway vehicles, and also as a stationary engine. The Panhard & Levassor and Peugeot vehicles, which scored success in the 1894 Paris - Rouen race, also used such engines.

The new engine was constructed like the single-cylinder Grandfather Clock engines of 1885: the closed crankcase was almost completely occupied by the crank webs acting as flywheel disks. The two cylinders formed an angle of 17 degrees with ignition spacing of 360 degrees. Thus, one rotation equated to a complete power stroke. Both connecting rods acted on a common crank bend. The cylinder head was water-cooled, the mixture was drawn in through automatic overhead intake valves, and the exhaust was discharged through controlled upright exhaust valves.

Daimler sought protection for the new two-cylinder V-engine from the German Imperial Patent Office in 1889, and in February 1890 was issued with the German Reich Patent No. 50 839. The version of the
V-engine installed in the wire wheel car had a displacement of 565 cubic centimeters and developed 1.5 hp (1.1 kW) at 700 rpm. The next generation already delivered two hp (1.5 kW) at 620 rpm.

At first, the V-engine still had the overflow valves known from the Grandfather Clock in the piston crown, which took care of overloading in the compression stroke. Daimler probably dispensed with that valve around 1890. One of the reasons for this, besides the complex mechanics, was the low additional output, since the charging in the piston hampered the operation of the uncontrolled intake valve. Panhard & Levassor likewise decided against the piston valve for their licensed engines.

French licenses for Daimler's wire wheel cars

Daimler demonstrated the wire wheel car in detail at the World Exhibition in Paris in 1889, where a Benz patent motor car was also shown. The French company Panhard & Levassor bought the licenses for the V-engine and the wire wheel car. The conclusion of this contract is considered to have sparked the creation of the French motor industry. By November 1889, Panhard & Levassor had already delivered the first engine built in France under the Daimler license to Barcelona, and the second unit followed in December.

In 1890, Panhard & Levassor, in turn, granted the tool and bicycle factory Peugeot the right to build engines under their Daimler license. The Peugeot Quadricycle was France's first fully operational road vehicle with an internal combustion engine.

The way to the four-cylinder engine

In 1889, Wilhelm Maybach amongst other things improved the suitability of Daimler engines for everyday use. He thus undertook tests with coolants that were mixtures of water and glycerol, in order to allow reliable operation of the engine even at temperatures below minus 10°C (14°F).

In 1890, Maybach's first four-cylinder in-line engine was also created. This engine was used only in boats, however. The engine developed five hp (3.7 kW) at 620 rpm. The cylinder dimensions were 80 millimeter bore x 120 millimeter stroke. With this engine, weighing 153 kilograms, Maybach had produced the archetype of later engine designs – even the drive systems of today are still based on the four-cylinder. For the new engine, Maybach developed a crankshaft with parallel bends for cylinders 1 and 4, as well as 2 and 3. The exhaust valves were controlled via a camshaft.

In August 1890, for the first time, a four-cylinder Daimler engine was delivered to New York as a marine drive system. The 451-kilogram engine had a six-liter displacement and developed 12.3 hp (8.8 kW) at 390 rpm. Ten days later, Daimler delivered a second model weighing only 153 kilograms. This smaller boat engine had a 2.4-liter displacement and delivered 5.9 hp (3.7 kW) at 620 rpm.

The Schroedter era

When, in 1891, the argument between Daimler and his business partners about the alignment of the model range escalated, Gottlieb Daimler and Wilhelm Maybach both resigned from Daimler-Motoren-Gesellschaft (DMG). At that time, DMG produced seven different gasoline engines: the single-cylinder at one hp (0.74 kW), V2 engines at 1.2 and four hp (0.74, 1.5 and three kW), as well as a parallel two-cylinder developing six hp (4.4 kW) output and the four-cylinder units developing a rated output of five hp (3.7 kW) and ten hp (7.4 kW), respectively.

Max Schroedter became the new chief engineer at DMG following the resignation of Daimler and Maybach. He immediately developed new two-cylinder engines with parallel cylinders. Such engines were also installed in the Daimler car with chain drive, the so-called Schroedter Car, launched in 1892. One of Schroedter's important innovations was the regulation of the mixture feed by throttling by means of a piston slide valve. Overall, however, the new engines did not prove to be technically mature.

Maybach's Phoenix engines

At the same time, Maybach continued to develop new vehicle drive systems. The work, which was initially carried out in Maybach's own home and later in the former Hermann Hotel, was privately financed by Gottlieb Daimler. Maybach's greatest success in this period is considered to be the Phoenix engine. This two-cylinder in-line engine was used for the first time in 1895 in the belt-driven car, after Daimler and Maybach had returned to DMG. When the 1000th Daimler gasoline engine was delivered in December 1895, the ceremony was once again held in the garden of Gottlieb Daimler's villa.

The company bowed to the pressure of the licensees who refused further contracts unless the two design engineers were once again responsible for the development of new products. This clearly demonstrated Daimler's international renown. Amongst other things, this was the result of victories in motor racing: the first automobile race in history is considered to have been the 1894 Paris – Rouen race organized by Pierre Giffard. The overall winners were motor cars by Peugeot and by Panhard & Levassor. Both brands used Daimler engines and achieved average speeds of approximately 18 km/h. In 1895, a race from Paris to Bordeaux and back was again won by cars with engines by Daimler/Maybach and by Benz.

The Phoenix engine was used in the belt-driven car with outputs of between two hp (1.5 kW) and 7.5/eight hp (5.5/5.9 kW) and displacements of 760 cubic centimeters to 2.2 liters. In place of the surface carburetor used up until then, Maybach's spray-nozzle carburetor, developed in 1893, now provided the carburetion. With the latter, the design engineer anticipated the principle of modern carburetors. Maybach had already laid out his preliminary ideas for the spray-nozzle system in 1891. After resigning from DMG, he perfected the carburetor in the rooms of the Hermann Hotel. By throttling the intake air by means of an annulus, Maybach provided a vacuum in the intake manifold. Because the gasoline was under atmospheric pressure, it was forced through the nozzle into the intake manifold, and atomized into a fine mist in the process.

Cooling with flywheel and tubular radiators

In 1892, Maybach also addressed the problem of engine cooling. With the increasing operational reliability and output of the engines, effective cooling became more and more important. The first solution he developed was flywheel cooling. Here, the warm coolant was routed into an open groove that was cast into the edge of the flywheel. A so-called ladle nozzle recovered the cooled water from this groove. However, the system worked only for engines with up to four hp (2.9 kW) output.

The solution for more effective cooling was the tubular radiator which Maybach conceived in 1897. This radiator consisted of a flat water box with open tubes inside which were exposed to the airflow. A fan coupled to the engine shaft provided efficient cooling even in the idle mode. The tubular radiator made possible the construction of much more powerful engines.

The first road vehicles with four-cylinder engines

In 1897, DMG introduced a new generation of motor cars which were the first Daimler automobiles to have front-mounted engines. Compared with the motor carriages with belt drive, a first crucial step had thus been taken in the direction of the modern automobile. The first model was driven by the proven Phoenix two-cylinder engine. The Daimler automobile also took its name from the engine: the Phoenix car.

The world's first road vehicles with four-cylinder engines were the Phoenix cars, presented in 1898, with Maybach's new four-cylinder in-line engine. The first two units of this model were delivered by DMG to Emil Jellinek in September 1898. They were driven by an eight-hp
(5.9-kW) 2.1-liter engine. During 1899, DMG offered other variants of the first series-built four-cylinder car engine. The output ranged from six hp (4.4 kW) to 23 hp (17 kW).

Bosch's magneto ignition

In 1897, the Robert Bosch company, established in 1886 in Stuttgart, developed its new contact-breaking ignition based on the widely used impulse ignition. This ignition technology was lighter and worked faster than its predecessor. In July 1898, a belt-driven Daimler car equipped with Bosch low-voltage magneto ignition successfully undertook a five-day trial run through the Austrian Alps. DMG also tested the new system in trucks. As a result of the knowledge gained, the hot-tube ignition characteristic of Daimler engine design was finally replaced.

Despite the fast pace of innovation in the development of automobile engines, DMG did not lose sight of other areas of engine design. Thus, in February 1899, Daimler equipped the airship of Count Zeppelin with gasoline engines. The four-cylinder light-alloy engine (N series) had a 4.4-liter displacement and developed 15 hp (11 kW) at 700 rpm. The maiden flight of the LZ 1airship, which was powered by two Daimler engines, took place on July 2, 1900.

Historical retrospective

In 1899, the automobile progressively became widely established as a new means of transport. Daimler-Motoren-Gesellschaft took advantage of this situation at the International Motor Show in Berlin that year, providing a first historical retrospective of the developments in engine design to date. In addition to the latest automobiles, the first Daimler engines from 1883 were displayed. This underscored the innovative achievements of the previous 16 years.

At this point, Wilhelm Maybach was already looking to the future: since 1896, the design engineer had been continually experimenting with aluminum as a material for engine construction. In a memo, he summarized the positive results of the 1899 tests thus: *"As much aluminum as possible."*

Controlled intake valves and honeycomb radiators

Maybach's engine developed in 1900 for the 35 hp Mercedes again featured several innovations. Thus, the engine with six-liter displacement and an output of 35 hp (26 kW) at 950 rpm was fitted with intake valves and exhaust valves that were controlled via two lateral camshafts. As a result of the construction with two valves arranged at the sides, the engine was also called the "hammer engine". For the first time, Maybach also replaced the tubular radiator with his new honeycomb radiator in this model. Its construction with numerous tubes and a square cross-section maximized the cooling surface, and made it possible to use less water in spite of improved cooling capacity.

Emil Jellinek ordered this first Mercedes in February 1900, and its development was complete in December 1900. After extensive testing and revision, in December the new vehicle was dispatched to Jellinek in Nice. Maybach had once again optimized the lightweight construction of the engine for the car: the power-to-weight ratio was 6.6 kilograms per hp, and was thus less than half of the 23-hp (17-kW) engine of 1898. The undersquare engine (116 millimeter bore x 140 millimeter stroke) made of light alloy allowed the car a top speed of almost 90 km/h. At the Nice Week in March 1901, Jellinek won three races in the 35 hp Mercedes.

Mercedes Simplex

The engine design of the first Mercedes also influenced the design of the Mercedes Simplex models. Their four-cylinder in-line engines developed between 32 hp (24 kW) at 1200 rpm with a 5.3-liter displacement and 65 hp (48 kW) at 1200 rpm with a 9.3-liter displacement. The 40 hp Mercedes Simplex, a more advanced development on the 35 hp Mercedes, was again driven by Emil Jellinek in the 1902 Nice Week.

For the new models of the Simplex series (18/22 hp model, 60 hp sports car and 90 hp racing car) presented in 1903, Wilhelm Maybach built completely new four-cylinder engines. These had an overhead intake valve in the center of the cylinder and an upright exhaust valve which was operated by means of push rods. In the combustion zone, the cylinders were cast with double walls in order for the coolant to pass through more efficiently.

Boat engines, hybrid vehicles and small cars

In addition to these new automobile engines, DMG presented a 300-hp (221-kW) six-cylinder marine engine for the Russian Navy in 1902. And the following year, the German boat "Mercedes," equipped with a Mercedes Simplex engine with 40 hp (29 kW) output, won the first boat race from Paris to the sea. The race covered a distance of more than 322 kilometers, and all six stages were won by Mercedes.

In 1902, Ferdinand Porsche won the Exelberg race with a hybrid vehicle of the Mercedes-Lohner-Porsche model in which the gasoline engine drove the electric wheel hub motors by means of a dynamo. The principle was also used by the Mercédès Mixte passenger cars presented by the Austrian Daimler-Motoren-Gesellschaft in 1906. Their 45-hp or 70-hp (33-kW or 51-kW) gasoline engines drove electric wheel hub motors in the front wheels by means of a generator.

Experiments with alternative drive systems based on the gasoline engines were common at the time. Thus, in 1904, Maybach worked on a gasoline-steam engine, which was intended to take advantage of the heat of the coolant via a heat exchanger. However, the principle did not work. In 1905, Maybach also abandoned tests with power transmission from the engine to the rear axle by means of compressed air. This method was intended to dispense with the transmission, clutch and differential. The compressed air produced by the engine by means of a pump was converted at the rear end into movement by two horizontally-opposed piston engines.

Paul Daimler did not attempt such a dramatic break with the design of the Simplex in his Austro-Daimler of 1903; the small car was driven by a transversely installed two-cylinder engine with nine hp (6.6 kW).

Six-cylinder by Maybach and Paul Daimler

The final development of the ingenious design engineer Wilhelm Maybach for Daimler-Motoren-Gesellschaft was a six-cylinder racing engine in 1906. Maybach arranged its cylinders individually on a light-alloy crankcase. The cylinder liners were made of steel, and the cylinders had overhead intake and exhaust valves that were controlled by means of camshafts and rocker arms. Each cylinder was equipped with two sparkplugs that were independent of one another. The oversquare engine (140 millimeter bore x 120 millimeter stroke) developed 106 hp (78 kW) at 1400 rpm and 120 hp (88 kW) at 1500 rpm. It was the archetype for many later engine designs, including aircraft engines.

Parallel to Maybach's racing engine, Paul Daimler developed a six-cylinder in-line engine for production vehicles – the new 37/65 hp and 39/75 hp Mercedes models. In the 75-hp (55-kW) top model, the engine had a 10.2-liter displacement. This car became DMG’s first production vehicle to feature a six-cylinder engine.

From model year 1908, the Mercedes vehicles acquired Bosch magneto sparkplug ignition systems. DMG was the first manufacturer to use the new low-voltage ignition system in production, and offered its customers the option of retrofitting older engines with this new system. Ignition was obtained with a dual ignition distributor and two sparkplugs per cylinder. This made it possible to ignite the mixture in parallel at different points of the cylinder. In high-performance engines, this technology prevailed for a long time.

The gasoline engine also became the norm for commercial vehicles: in 1910, the Breslau fire brigade commissioned the first mobile turntable ladder on a Daimler chassis with gasoline engine. It was thus the first fire service in Germany to possess a fire-fighting fleet made up only of motor vehicles with gasoline engines. All three vehicles (motor-driven fire pump, turntable ladder and implement carrier) were produced on a 28/32-hp chassis by Daimler Marienfelde.

The era of the Knight sleeve valve engines

Under Paul Daimler, who in 1907 took over as chief engineer of DMG from Wilhelm Maybach, Daimler-Motoren-Gesellschaft entered into a preliminary agreement for the licensed manufacture of the valve-free sleeve valve engines of Charles J. Knight in 1909. After trial production of one of the American engines, in 1910 the decision was made to commence production of these engines for Mercedes vehicles. Advantages of the sleeve valve engine included its quiet running and the possibility of obtaining high engine speeds of up to 1600 rpm in four-cylinder engines.

In December 1910 at the Paris Motor Show, DMG was already showing a landaulet with a valve-free Knight sleeve valve engine. The production of a 16/40 hp Mercedes-Knight (later 16/45 Mercedes-Knight) began in early 1911. However, the slide valve gear proved to be mechanically fragile and too complex in production. In total, only around 5500 vehicles with engines of the Mercedes-Knight type were produced.

Three- and four-valve technology

The 37/90 hp Mercedes was the new top-of-the-line model of DMG in 1911. Its four-cylinder engine had a 9.5-liter displacement and was equipped with three valves per cylinder (including two exhaust valves) and dual ignition. The design made up of single cylinders with welded coolant jackets replaced the six-cylinder units produced since 1907.

In 1914, Daimler-Motoren-Gesellschaft also successfully introduced multi-valve technology in the engine of the Grand Prix car. The four-cylinder in-line unit had individual upright steel cylinders and cylinder heads equally made of steel. In each case, two intake and exhaust valves were arranged obliquely in the countersunk roof-shaped cylinder head. Ignition occurred with three sparkplugs per cylinder head. This engine, with its high engine speeds (105 hp/77 kW at 3100 rpm, maximum engine speed 3200 rpm), became the prototype for aircraft engines and others.

Daimler aircraft engines

Aircraft engine production had already begun at DMG in 1909 with the completion of the first 120-hp (88-kW) four-cylinder

J 4 F. In the same year, a 30-hp (22-kW) B 4 F and the first unit of the 60-hp (44-kW) four-cylinder D 4 F were produced. In 1913, the Mercedes DF 80, a 90-hp (66-kW) 7.2-liter six-cylinder, took second place in the Emperor's prize for the best German aircraft engine.

In 1917, the Sindelfingen plant was also commissioned with the manufacture of aircraft engines. Those in charge of the air force thus intended to boost the production of Mercedes aircraft engines, which until then had been concentrated in Untertürkheim, and at the same time to decentralize it. In March 1918, the first Sindelfingen workshops began aircraft engine production. In the fall, the necessary test benches were installed. Owing to the lack of machines, however, the first engines could not complete their test bench run until shortly before the end of the war.

The supercharger era

A powerful howling noise announced the triumph of a new generation of sporty automobiles: in 1921, at the Berlin Motor Show, DMG presented the world's first passenger car with a supercharged engine. The engines of the four-cylinder 6/20 hp Mercedes and 10/35 hp Mercedes were provided with air under excess pressure by means of a double-bladed Roots blower to boost power output. The two cars, whose output in the meantime had once again been improved, went into production in 1923 as the 6/25/40 hp and 10/40/65 hp models. In the model designation, the first number designated the tax horsepower rating, the second the engine output without a supercharger, and the third number designated the engine output with the supercharger engaged. The engines had V-shaped overhead valves, a vertical shaft, and individual steel cylinders, and were combined to form a block in a welded sheet steel jacket. This high-performance engine was designed by Paul Daimler based on the example of aircraft engines from the First World War. The technology for mechanical charging using a compressor also originated from these aircraft engines.

Initially, the four-cylinder models with 1.6-liter (6/25/40 hp) and 2.6-liter (10/40/65 hp) engines were equipped with superchargers. The six-cylinder engines with four-liter displacement (15/70/100 hp) and 6.2 liters (24/100/140 hp) followed. After the merger of Benz & Cie. with Daimler-Motoren-Gesellschaft in 1926, even the large eight-cylinder cars (380, 500 K, 540 K, 770) as well as Mercedes-Benz's sports and racing cars likewise acquired supercharged engines. The mechanical charging not only served as a means of boosting output, but was also a characteristic of the prestigious high-performance vehicles from Stuttgart. The supercharger thus defined the image of Mercedes-Benz with the values of performance, innovation and dynamism.

Even before series production of the supercharged cars, DMG had achieved race successes with mechanically charged vehicles. At the Targa Florio in 1922, Max Sailer was the winner in the production car category in a 28/95 hp model which was equipped for the race with a supercharger. The Targa Florio 1922 was the first race in which supercharged cars were entered.

At the Berlin Motor Show in December 1924, Daimler presented the new 15/70/100 hp and 24/100/140 hp Mercedes passenger car models. The two supercharged six-cylinder cars would, in future, serve as top-of-the-line models in the sales range.

The first eight-cylinder Mercedes, and at the same time the first car designed by Ferdinand Porsche for DMG, was the two-liter Monza racing car. The supercharged racing car had its first race – the Italian Grand Prix in Monza – in October 1924. Porsche's design achieved greater successes only in various national races, and, as in the AVUS race, in the four-seater sports car category. Its output of 170 hp (125 kW) at 7000 rpm allowed a top speed of 180 km/h.

The Mercedes-Benz gasoline engine from 1926 on

- **Reliable engines guaranteed satisfied customers**
- **First-class performance and prestige with the supercharger**
- **Continued refinement of detail features**

After the merger of Daimler-Motoren-Gesellschaft with Benz & Cie. to form Daimler-Benz in 1926, older models of both brands continued to be built at first. The first completely newly designed vehicle of the brand was the 5/25 hp Mercedes-Benz prototype (W 01 series) with the six-cylinder in-line M 01. This undersquare engine with 1.4-liter displacement was designed by Ferdinand Porsche. However, neither this model, which, in its displacement category, was unusually refined, nor the 5/25 hp Mercedes-Benz (W 14) with a 1.3-liter four-cylinder M 14 engine ever made it to large-scale production.

The first newly developed Mercedes-Benz production car was therefore the 8/38 hp model (W 02 series) with the two-liter in-line six-cylinder M 02. The very undersquare engine (65 millimeter bore x 100 millimeter stroke) developed 38 hp (28 kW) at 3400 rpm. This car was based on DMG's plans for a supercharged two-liter car, and, following an exchange of argumentation with Benz & Cie., it was modified and became a vehicle with a more simple design for the sake of high production figures.

Continuous development

The model presented in 1926 did not represent a technical milestone in Mercedes-Benz engine development. Instead, the design engineers worked from a proven technological basis for the in-line engine. Nevertheless, the M 02 had great potential for future development. Over a period of twelve years, and in several stages, engines with increased displacement evolved from this basis for subsequent passenger car generations: for example, the M 11 of the 2.6-liter variants of the 1928 Mercedes-Benz Stuttgart, the M 18 2.9-liter engine of the 1933 Mercedes-Benz 290 (W 18), and finally the M 142 of the Mercedes-Benz 320 (W 142 I), presented in 1937, with a
3.2-liter engine, which in 1938 was increased to 3.4 liters.

Such continuous development of proven engines over a long period of time has always been responsible for the high quality of Mercedes-Benz engines. The pursuit of the systematic improvement of good products in their every detail was the impetus for this technical evolution.

From Mercedes K to Mercedes-Benz S

Taking up the thread of the short, but glorious history of the big Stuttgart supercharged sports cars, in 1927 Mercedes-Benz launched the W 06 series of supercharged sports cars, beginning with the Mercedes-Benz S (26/120/180 hp) – the S standing for "sport".

A new chassis was developed, based on the chassis of the Daimler K model. The Mercedes-Benz S acquired a low frame, and the engine was moved backwards by 30 centimeters. The axle load distribution was thus improved, and the M 06 large-volume six-cylinder in-line engine could be installed much lower. The M 06 had a displacement of 6.8 liters, owing to enlarged bores. In addition, major modifications compared with the Mercedes K were necessary in the engine block. The engineers thus changed from dry to wet cylinder liners; however, the engine still had dual ignition and two sparkplugs per cylinder, one of which, in each case, was supplied by means of the traditional high-voltage magneto ignition and the other by means of battery ignition. Together with the upper part of the crankcase, the cylinders were cast from aluminum, and the cylinder head was made of gray cast iron. Intake and exhaust valves were arranged overhead in the cylinder head, while valve control was carried out by an overhead camshaft. In combination with a two-carburetor system, the new sports car engine officially developed 180 hp (132 kW) with a supercharger. Engines with higher compression developed up to 220 hp (162 kW) in racing with the help of a special benzene mixture as fuel.

The first entry of the Mercedes Benz S in the German Grand Prix in the summer of 1927 resulted in a triple victory on the Nürburgring, with Rudolf Caracciola taking first place. However, a press release of 1928 also emphasized the suitability of this high-performance engine for everyday use: "*The engine – in contrast to the sensitivity which is so often found in race engines – is particularly powerful, resilient and reliable, and built for a long service life, not just for a few hours of racing under extreme stresses*."

From S to SSKL

The evolution of the Mercedes-Benz S sports car to the SSKL occurred in the years after 1927, in particular as a result of improvements to the engines. The SS model presented in 1928 had an engine with a

7-liter displacement. The maximum output with a supercharger was initially 200 hp (147 kW) and continually increased to 220 hp (162 kW), then 225 hp (165 kW), and ultimately 250 hp (184 kW). The supercharged engine with a maximum engine speed of 3200 rpm was considered a low-speed engine, since engine speeds of pure racing engines of the time were more than twice as high.

The SS thus offered either a high level of comfort when touring or full performance for racing purposes. Mercedes-Benz also described the car to potential buyers in these terms: *"[The driver] now uses the less powerful or more powerful engine at his own discretion, depending on whether he requires greater acceleration and tractive power for his journey. Generally, he will only need the supercharger in order to reach the desired traveling speed more quickly, and then continue at this speed without the supercharger, or he will engage the supercharger on uphill stretches where he must change down to the next lowest gear, or which are taken with the engine at too low a speed. Racing is a different story. Here, one always drives with the supercharger engaged, unless the road characteristics (bends, etc.) prohibit this*."

The W 06 series was completed with the SSK and SSKL models. The SSKL racing sports car developed 300 hp (220 kW) from its 7.1-liter engine with mechanical charging. With this car, Rudolf Caracciola and Wilhelm Sebastian won the Mille Miglia in 1931 at an average speed of 101.1 km/h. Caracciola was thus the first non-Italian driver to win the thousand-mile race with start and finish in Brescia.

The first Mercedes-Benz eight-cylinder

In 1928, the 18/80 hp Mercedes-Benz Nürburg 460 (W 08) was the first Mercedes-Benz passenger car with an eight-cylinder in-line engine. For that reason, it was also called the "Nürburg 8" in some publications, and the front cover of the early catalog was decorated with a gold-embossed number 8 surrounded by a diamond. The prestigious vehicle was designed by Ferdinand Porsche. His successor, Hans Nibel, revised the W 08 after just one year, and gave the Nürburg a more elegant and sportier form. The M 08 engine – a 4.6-liter eight-cylinder in-line unit – remained the same. The engine was controlled by a lateral camshaft and developed 80 hp (59 kW) at 3400 rpm.

The M 07 engine had its premiere in 1930 as Mercedes-Benz's second eight-cylinder engine, powering the 770 Grand Mercedes. From a
7.7-liter displacement, the engine developed 200 hp (147 kW) at 2800 rpm with the supercharger engaged. The mixture was provided by a Mercedes-Benz three-nozzle double carburetor. The W 07 was in every respect a prestigious vehicle that satisfied the very highest demands. The top speed of 160 km/h was perfectly suited to the respective driving conditions.

Innovative compact car with rear-wheel drive

While the eight-cylinder models served to emphasize Mercedes-Benz's position in the luxury class, at the same time the engineers were working on innovative concepts for compact sedans. The result of this research was the 130 (W 23) model of 1934, whose four-cylinder engine with 1.3-liter displacement was housed in the rear of the car. This model was thus the first Mercedes-Benz passenger car to have a rear-mounted engine as standard. The 170 H (W 28) model, presented in 1936, also had a four-cylinder gasoline engine mounted in the rear.

Mercedes-Benz aircraft engines

Many innovations in Daimler-Benz engine production in the 1930s were based on aircraft engines. Thus, the LZ 129 Zeppelin airship, better known as the Hindenburg, was driven by four Daimler-Benz V16 engines from the DB 602 (LOF 6) series, each with a maximum output of 1200 hp (882 kW).

In 1937, the DB 601 A, a V12 engine with overhead cylinders, went into production as the first Daimler-Benz aircraft engine with gasoline injection. Using the more advanced DB 601 Re V aircraft engine in the Messerschmitt Me 209 record aircraft, in 1939 aircraft captain Fritz Wendel achieved a record speed of 755.138 km/h, which would not be beaten for 30 years.

Wartime

During the Second World War, activities to develop gasoline engines for passenger cars at Mercedes-Benz were for the most part confined to reacting to the difficult supply conditions. In 1943, the Stuttgart engineers thus presented a wood gas generator for the 170 V passenger car that weighed only 70 kilograms, cost 800 Reich marks and could be installed in one day, and which permitted a range of approximately 100 to 130 kilometers with a charcoal load of 24 kilograms.

Mercedes-Benz gasoline engines after the Second World War

- **First completely new developments: six-cylinder engines in models 220 and 300**
- **300 SL coupe: First production car with fuel injection**
- **First Mercedes-Benz V8 in the 600 (W 100)**

In 1946, when production was resumed under difficult conditions after the end of the war, Mercedes-Benz fell back on proven engines from the prewar range. The first post-war passenger car engine built in Untertürkheim was a 1.7- liter four-cylinder engine for the 170 V.

1951: A new beginning

The first completely new designs to start production after the end of the war were the engines of the six-cylinder Mercedes-Benz 220 (W 187) and 300 (W 186) passenger cars. Both cars were shown at the first Frankfurt International Motor Show (IAA) in 1951.

The M 180 engine of the 220 had a 2.2-liter displacement and an output of 80 hp (59 kW). The engine was designed as a typical oversquare engine with an overhead camshaft, overhead valves in the cylinder head, and a crankshaft running in lead bronze bearings with new, patented mounting of the weights. The camshaft drive was silent and provided by a Duplex roller chain, while the mixture was produced by a Solex downdraft carburetor.

The foremost attention-grabber at the 1951 IAA, however, was the Mercedes-Benz 300 (W 186). At the time of its presentation, this model was the largest and fastest production car of all the German brands. Later, the model was simply called the “Adenauer,” after German Federal Chancellor Konrad Adenauer who liked to be driven in the Mercedes-Benz 300. The output of the three-liter engine was increased several times from 1951: the 115 hp (85 kW) at 4600 rpm of the first W 186 I model was further advanced to 125 hp (92 kW) at 4500 rpm in the last version with the M 186 II engine.

The press release said of the engine of the new car, the M 186: *“[It] represents not only the sum of the last decade’s experience and design knowledge, but also incorporates concepts that had not been applied until now.”* One example of these innovations was the oversquare engine design with slow piston speed, which resulted in less wear and a long life. A novel valve arrangement allowed large valve cross-sections in spite of a small surface, and promoted vortex formation in the combustion chamber. The ignition point was regulated by means of a centrifugal governor and an aneroid capsule in the intake manifold, and in addition there was the possibility of precision adjustment on the dashboard.

With the installation of the new M 189 engine in the 300 d model (built from 1957 to 1962) with manifold injection, the engine output was again increased to 160 hp (118 kW) at 5300 rpm. Another high-speed carburetor engine, the M 188, was already provided in the Mercedes-Benz 300 S (W 188 I) coupe in 1951. This was replaced by the M 199 injection engine in 1955. The engine output was thus increased from 150 hp (110 kW) at 5000 rpm to 175 hp (129 kW) at 5400 rpm, while the fuel consumption did not change.

Arrival of the Mercedes-Benz 300 SL

The Mercedes-Benz 300 SL sports car was conceived in 1954 based on the racing sports car prototype presented in 1952. The coupe was the world's first production car with a four-stroke engine that was provided with gasoline injection. The 300 SL featured mechanically controlled direct injection via a Bosch six-plunger pump. With this technology, the M 198 engine developed 215 hp (158 kW) at 5800 rpm. With the engine design of the 300 SL, Mercedes-Benz set the standards for the development of future generations of gasoline engines, just as it did with the entire sports car concept. The 300 SL roadster presented in 1957 retained this injection technology. In 1962, however, the six-cylinder in-line engine installed inclined at 45 degrees was fitted with a new light-alloy block.

The Mercedes-Benz 300 d was equipped with a fuel injection system in 1957. In this case, however, Mercedes-Benz opted for intermittent manifold injection. The injection again took place by means of a Bosch six-plunger pump.

The Mercedes-Benz 220 SE (W 128) with the M 127 I six-cylinder in-line engine appeared in 1958. The injection system of the 2.2-liter engine was powered by a Bosch two-plunger pump. The engine developed 115 hp (85 kW) at 4800 rpm. The technology for increasing output, which had been established for many years already, had finally been adopted into large-scale production with this model. The additional cost compared with the 220 S model with carburetor engine was 1900 deutschmarks.

Gasoline engines in the three-box body

A good example of the development of new engines within a model series was the Mercedes-Benz with three-box body (with self-supporting chassis-body structure, known as “Ponton” in German). The 180 (W 120) model, presented in 1953, had an M 136 II four-cylinder in-line engine with 1.8-liter displacement for the first four years. The engine developed 52 hp (38 kW) at 4000 rpm. In 1957, the engine was replaced by the new 1.9-liter M 121 engine which also powered the 190 model. Instead of lateral upright valves, the cylinders now had overhead valves, while the lateral camshaft was replaced with an overhead variant. The output was increased to 68 hp (50 kW) at 4400 rpm, while at the same time fuel consumption fell by one liter to 10.5 liters per 100 kilometers.

For the 1957 model year, the six-cylinder models 219 (W 105) and 220 S (W 180 II) were fitted with engines with increased output and the Hydrak hydraulic-automatic clutch as an option.

Continuous development of the four- and six-cylinder engines

In the 1960s, in new model series such as the Tailfin, Mercedes-Benz focused on the continuous development of existing engines. The 190 (W 110) model was thus fitted with the latest version of the M 121 engine. In 1956, it had developed 75 hp (55 kW) at 4600 rpm and consumed 11.5 liters of premium gasoline per 100 kilometers in the 190 (W 121) model. At the same consumption, the output had now increased to 80 hp (59 kW) at 5000 rpm, and the top speed was approximately 150 km/h instead of 139 km/h. The designers obtained this optimization in spite of a larger and heavier bodywork which was built based on Béla Barényi’s innovative concept for maximizing passive safety.

The top-of-the-line model in this series was the 300 SE (W 112) presented at the IAA in 1961. Its M 189 injection engine initially had a two-plunger injection pump, and from 1964 a six-plunger pump was installed. Thanks to modifications of the three-liter engine, the output was increased from 160 hp (118 kW) at 5000 rpm to 170 hp (125 kW) at 5400 rpm. The fuel consumption of the car equipped with automatic transmission as standard changed as a result of the more powerful engine, while the increased top speed did not.

Mercedes-Benz 600: A class apart

In the Mercedes-Benz 600 (W 100), the Stuttgart brand presented a V8 injection engine for passenger cars for the first time. The oversquare eight-cylinder (103 millimeter bore x 95 millimeter stroke) engine developed a maximum output of 250 hp (184 kW) at 4000 rpm from 6.3 liters. Together with the automatic transmission installed as standard, the W 100 had a performance that would also have done credit to a sports car: the sedan, although weighing almost two-and-a-half tons, achieved a top speed of over 205 km/h and accelerated from standstill to 100 km/h in ten seconds.

At the start of planning, the engineers had considered designing the M 100 as a five-liter engine. The decision to produce a light-alloy V8 was made as early as 1955. Parallel to the M 100, the engine specialists also worked on a V12 engine, which was given the in-house code M 101. This engine, which was to have a 7.5-liter displacement, was not realized, however.

Finally, in the Mercedes-Benz 600, a groundbreaking engine was used with cylinder banks made of gray cast iron, aluminum cylinder heads, and a 6.3-liter displacement. The innovative V8 engine, which easily outperformed comparable engines of American brands in terms of output and refinement, finally became the powerhouse of the Mercedes-Benz 300 SEL 6.3 (W 109 E 63). Here, the 250-hp engine was responsible for the sedan's top speed of 221 km/h. Engine power was transferred to the road by a four-speed automatic transmission.

The M 100 also inspired the smaller V8 engines of the 1970s: the 3.5-liter M 116 engine was employed in the Mercedes-Benz 300 SEL 3.5 (W 109 E 35/1) and 280 SE/SEL 3.5 (W 108 E 35) models. The injection engine developed 200 hp (147 kW) at 5800 rpm. In addition, the M 117 engine with 4.5-liter displacement was developed for export to North America.

Independent mid-series: The Stroke Eight

In the first independent model series of the mid-sized category (W 115/114), Mercedes-Benz focused on proven engine technology. The 200, 220 (W 115), and the 230 and 250 (W 114) models had in-line carburetor engines with overhead valves and an overhead camshaft.

In April 1972, the 280 and 280 E models were added to the sedan model line-up. Both were equipped with a newly designed 2.8-liter engine with a double overhead camshaft. The carburetor version of this M 110 six-cylinder in-line engine developed 160 hp (118 kW) at 5500 rpm and as an injection engine 185 hp (136 kW) at 6000 rpm. Since the arrival of the 280 and 280 E, the 250 model was no longer delivered with the 2.5-liter M 114 engine, but instead with the 2.8-liter M 130 engine which was also used in the 280 S (W 108 V 28). In the Stroke Eight, a slightly derated variant was used that developed 130 hp (96 kW) at 5000 rpm instead of 140 hp (103 kW) at 5200 rpm. The export version of the 250 model for the USA and Canada had been equipped with this engine since July 1970.

The M 110 in the Mercedes-Benz 280 had V-shaped overhead valves and two overhead camshafts. The carburetor version created the mixture with a dual-compound downdraft carburetor, while the 280 E had an electronically controlled injection system by Bosch. Gasoline injection had long been established in the Mercedes-Benz model range when the Stroke Eight was launched: the 250,000th Mercedes-Benz passenger car with an injection engine had been built in the Sindelfingen plant in 1969.

Mercedes-Benz demonstrated far-sightedness in 1968 with the presentation of a new five-speed transmission for all cars with six-cylinder engines. Demand was still low at the time, and production was suspended again in 1976. In the early 1980s, however, five-speed transmissions were suddenly in great demand because many motorists wished to reduce fuel consumption with this modern technology.

Three V8 engines in the S-Class

The Mercedes-Benz S-Class of the 116 series, presented in 1972, was offered with a total of three different V8 engines. The 280 S/SE served as entry-level model with the M 110 as carburetor or injection engine (160 hp/118 kW and 185 hp/136 kW, respectively). The output of the dual-camshaft engine changed between November 1975 and February 1976, when the fuel-

injection systems of the 2.8-liter, 3.5-liter and 4.5-liter injection engines were converted.
Mercedes-Benz changed from the electronically controlled Bosch D-Jetronic to the newly developed, mechanically controlled Bosch K-Jetronic in order to be able to better conform to the emissions standards that in the meantime had become stricter in most European countries. In order to facilitate maintenance, the two V8 engines were provided in the context of these measures with contactless transistorized ignition and hydraulic valve clearance compensation. In all three cases, the conversion was initially associated with minor output losses; from April 1978, the original output of the three models with modified injection engines was again fully available.

In addition to the 3.5-liter V8 M 116 and the 4.5-liter M 117 engine originally designed for North America, in the 116 series the V8 M 100, which had proven itself in the Mercedes-Benz 600, was also used. With an increased displacement of just under 6.9 liters and developing 286 hp (210 kW) at 4250 rpm, it powered the top-of-the-line Mercedes-Benz 450 SEL 6.9 model. This sedan, presented in 1975, had a K-Jetronic injection system controlled by an airflow sensor.

The top-of-the-line models in the 107 series at this time were the Mercedes-Benz 500 SL roadster and the 500 SLC coupe of 1980. They were equipped with the M 117 V8 engine with a displacement of just under five liters, which had already been employed in a similar form in the 450 SLC 5.0 of 1978.

Launch of the 123 series with a new six-cylinder in-line engine

When Mercedes-Benz launched the new mid-sized 123 series in 1976, the proven gasoline engines of the 115/114 series were installed in the 200, 230, 280, and 280 E. Only the Mercedes-Benz 250 received a completely newly developed six-cylinder in-line engine, the M 123, with a 2.5-liter displacement and an output of 129 hp (95 kW) at 5500 rpm. In the engine range of the 123 series, however, some changes were made in the years from 1978 to 1980. Initially, in April 1978, the output of the 280 E was increased to 185 hp (136 kW) at 5800 rpm. In September 1979, the output of the six-cylinder carburetor engine in the 250 was boosted to 140 hp (103 kW) at 5500 rpm.

In June 1980, Mercedes-Benz introduced two new gasoline engines: the M 102 two-liter carburetor engine developing 109 hp (80 kW) at 5200 rpm and the M 102 injection engine, a 2.3-liter unit developing 136 hp (100 kW) at 5100 rpm. The two variants of the M 102 replaced the proven engines of the M 115 series. The all-new M 102 four-cylinder in-line engine was designed for installation at an angle in order to keep the overall height as low as possible. This specification was important so that the engine could also be used in future model generations. The new engine's output had been boosted by 15 – 25 percent while fuel consumption was up to ten percent lower.

The engineers had thus reached the development goal for the M 102, namely to create power reserves and improve fuel economy. Moreover, the smooth operation of the four-cylinder was intended to approximate the six-cylinder in-line engines. Compared with this more complex engine model, the four-cylinder had the advantages of high torque, in particular in the important lower engine speed range, and higher efficiency as a result of its smaller friction losses. In the press release for the new engine, Mercedes-Benz also emphasized that, in the M 102, "*no structural experiments*" had been made, but instead the engine represented "*an optimum compromise of all of the requirements for a passenger-car engine that was economical, suitable for everyday use, and reliable*."

The cylinders of the new engine were provided with hemispheric combustion chambers with a squish lip in the cylinder head. This was intended to guarantee maximum swirl to be able to ignite even very lean mixtures. Intake and exhaust ports faced each other in accordance with the cross-flow principle. To be able to increase the exhaust ports, sparkplugs with a size of only 16 millimeters were used.

End of joint production network for gasoline and diesel engines

To build a gasoline engine optimized in this way, Mercedes-Benz had to abandon the integrated production network that had been partially established between gasoline four-cylinders and diesel passenger-car engines. This network had its origins in the 1950s and had been established against the background of much lower production figures at the time.

The concentration on engine blocks purely for gasoline units allowed the employment of very precise structural measures for weight reduction. Thus, for the four-cylinder in-line engine, the engineers did not use light alloy but particularly thin wall thicknesses made of gray cast iron instead. Unlike in V8 engines, light alloy would not have yielded such significant weight reductions.

V-engines for the W 126 S-Class

In 1979, Mercedes-Benz presented the new S-Class (W 126 series) with two revised eight-cylinder engines. The V8 engines of the predecessor series were replaced by engines with increased displacement and a light-alloy crankcase. The five-liter M 117 E 50 engine that replaced the 4.5-liter gray cast-iron engine had already been fitted in the 450 SLC 5.0. The engineers developed the 3.8-liter light-alloy M 116 E 38 engine based on the example of the five-liter engine from the veteran 3.5-liter V8 with a gray cast-iron block. Owing to their higher output at a lower weight, the new V8 engines allowed improved performance with greater fuel economy. Unchanged in the range were the carburetor version and the injection version of the

2.8-liter six-cylinder: these were both proven engines with a dual camshaft.

In 1981, as part of the Mercedes-Benz energy concept for reducing consumption and pollutant emissions, the company thoroughly revised the V8 engines. In addition to an increase in compression, camshafts with changed valve timing, air-bathed injection valves, and electronic idling speed control figured on the list of improvements. Owing to the changed camshaft tuning, the maximum torque could be shifted to lower engine speeds, and in the 3.8-liter engine even increased. This engine underwent particularly radical changes: in order to achieve a more favorable volume-to-surface ratio, the bore was reduced and the stroke increased. The modified 3.8-liter V8 now had a slightly increased displacement.

In the two eight-cylinder engines, slight output losses had to be accepted, compensating to some extent for the considerably improved economic efficiency. In the two six-cylinder engines, there was also a range of detail modifications with resulting savings, although these were less pronounced. The output potential was not compromised as a result of these measures.

In 1985, Mercedes-Benz presented a completely revised S-Class line-up with new engines. Two newly designed six-cylinder engines replaced the proven M 110: instead of the carburetor model, a
2.6-liter injection engine (M 103 E 26) was now used, while the three-liter M 103 E 30 engine, developed in parallel, succeeded the injection variants of the M 110. Also new to the range was the 4.2-liter V8 M 116 E 42 engine which was created by enlarging the displacement of the 3.8-liter engine and now replaced the latter in

the S-Class sedan, in the SEC coupe, and in the SL. The five-liter engine was now equipped with an electronic ignition system and the electronically and mechanically controlled Bosch KE-Jetronic injection system, and developed an output of 245 hp (180 kW) at 4750 rpm.

The most spectacular new unit in the engine range was the 5.6-liter eight-cylinder M 117 E 56. It was developed from the five-liter V8 by lengthening of the stroke and delivered 272 hp (200 kW) at 5000 rpm. Mercedes-Benz even provided a higher compression version as an option, which delivered an impressive 300 hp (220 kW), but which could not be combined with a closed-loop emission control system. At the time of their launch, the 560 SEL and 560 SEC models equipped with this engine variant were the most powerful production cars that Mercedes-Benz had ever built.

In September 1987, more powerful variants of all V8 engines were introduced. This was particularly evident in the vehicles with catalytic converters: by optimizing the emission control system, it was possible to significantly reduce the loss of output due to the catalytic converter.

Catalytic converters fitted as standard

In 1985, a closed-loop emission control system with a three-way catalytic converter was available as an option for all variants of the revised model range, with the exception of the ECE versions of the 560 SEL and 560 SEC. Cars were supplied as standard with provisions for retrofitting catalytic converters – i.e. without catalytic converter and oxygen sensor, but with the multi-functional mixture formation and ignition system. The closed-loop catalytic converter could be retrofitted at any time and without difficulty.

Then, from September 1986, the catalytic converter was included in the standard equipment of all Mercedes-Benz passenger car models with gasoline engines. Cars suitable for retrofitting were still available on request – with an appropriate markdown – until August 1989.

The 1981 Mercedes-Benz energy concept

The results of different research projects influenced the Mercedes-Benz energy concept, which was presented in 1981 at the Frankfurt International Motor Show (IAA). The efforts of Mercedes-Benz to optimize fuel consumption and protect the environment were rewarded in 1982, for example, when Werner Breitschwerdt was awarded the energy saving prize. Breitschwerdt was head of Research and Development at Mercedes-Benz at the time, and in 1983 was appointed chairman of the Board of Management of Daimler-Benz AG.

The energy concept resulted in reductions in the fuel consumption of the different Mercedes-Benz models with gasoline engines of between three and 22 percent, without loss of performance. The new four-cylinder engines introduced in 1980 were already so advanced that the measures had the smallest impact here. By contrast, the fuel consumption of other models was reduced by a myriad of intelligent measures. This included the electronically controlled fuel cut-off in deceleration mode for 2.3-liter injection engines and overrun cut-off for the 2.5-liter six-cylinder (M 123).

Here, extensive work on the V8 engines resulted in reductions in consumption of between 19 and 22 percent. Individual measures included lowering the engine idling speed, fuel cut-off on the overrun, the improvement of warm-up and combustion processes in the cylinder, the reduction of all output and frictional losses, the development of more compact combustion chambers, optimized fuel atomization, and the use of a new transistorized ignition.

In addition, Mercedes-Benz introduced a manual five-speed transmission – with overdrive fifth gear – as optional equipment for four-cylinder models. By contrast, the six-cylinder in-line engines of the 123 series were fitted with the new automatic transmission from the S-Class. In 1982, the five-speed transmission, also in combination with the six-cylinder engines, could be supplied for all models that were fitted with a four-speed transmission as standard. Even the 280 SL was equipped with this feature as standard.

Renaissance of four-valve technology in the Mercedes-Benz 190

The Mercedes-Benz 190 (W 201), presented in 1982, was the brand's first car in the compact class after the Second World War. At first, it was delivered with two engines from the M 102 engine family: the 190 model had a carburetor engine whose output, by reducing the size of the intake and exhaust ports and using a modified camshaft and smaller valves, was derated from 109 hp (80 kW) to 90 hp (66 kW). The 190 E, by contrast, acquired an engine with newly developed gasoline injection by means of the Bosch KE-Jetronic mechanically and electronically controlled injection system, and developed 122 hp (90 kW). The engines, installed at an angle of 15 degrees to the right, had contactless transistorized ignition which was once again smaller and lighter than in the W 123. Electronic cold-running control yielded fuel savings in the warm-up phase.

In 1983, in this model series, four-valve technology experienced a renaissance at Mercedes-Benz: the 190 E 2.3-16 model was a sporty variant of the compact-class sedan with excellent performance. The car's characteristic feature was its engine's great flexibility. For each cylinder, the sixteen-valve engine had four V-shaped overhead valves, which were controlled by two overhead camshafts. Air-bathed injection valves were located in each case just in front of the division of the intake ports, and injected the fuel into the eight ports in a uniform manner. From a 2.3-liter displacement, the engine developed 185 hp (136 kW) at 6200 rpm. This compact class car accelerated from standstill to 100 km/h in 7.5 seconds, the maximum torque of 235 Newton meters was generated at approximately 4500 rpm, and the top speed was 230 km/h. These were excellent performance figures: Mercedes-Benz had thus designed the new 190 in the tradition of the Grand Prix car of 1914.

Production of the 190 began in 1984. In the press release issued on this occasion, Mercedes-Benz emphasized the significance of four-valve technology: the use of four valves per cylinder, set at an angle of 45 degrees was said to be "*a concept that, in contrast to the turbocharger, produced excellent volumetric efficiency in all engine speed ranges and allowed a high output*." The filling of the cylinders with their roof-shaped combustion chambers was aided by defined resonant vibrations in the intake and exhaust pipes.

The new 190 E 2.5-16 model replaced the sixteen-valve 2.3-liter engine in 1988. The M 102 E 25/2 was developed from the engine of the predecessor model by lengthening of the stroke, and with a catalytic converter developed a maximum output of 195 hp (143 kW) at 6750 rpm, 25 hp (18 kW) more than its predecessor.

In March 1989, Mercedes-Benz presented the 190 E 2.5-16 Evolution at the Geneva Motor Show. The newly developed 2.5-liter oversquare engine, which was protected against overspeeding, likewise developed 195 hp (143 kW) in the production version, but was designed such that measures could be undertaken to increase its output. A further development stage was presented a year later, again at the Geneva Motor Show, in the form of the 190 E 2.5-16 Evolution II model. The engine now developed 235 hp (173 kW) at 7200 rpm and thus allowed even better performance.

New six-cylinder in the 124 series

At the presentation of the new mid-sized 124 series, Mercedes-Benz also presented new six-cylinder in-line engines in 1984. In order to reduce frictional losses and weight, the six-cylinder in-line versions of the M 103 engine, with displacements of 2.6 and three liters, had only one camshaft. Combustion chambers with squish areas allowed higher turbulence in the cylinder and made even lean mixtures easy to ignite. In both engines, the coolant chambers were reduced in size, which made quicker warm-up easier. The engines were equipped with a mechanical-electronic injection system – the 2.6-liter version with this design replaced the 2.8-liter carburetor engine of the predecessor series.

In these new six-cylinder in-line engines, the mechanically and electronically controlled gasoline injection featured a microprocessor-controlled unit which carried out various control and correction functions. Amongst other things, these included warm-up adjustment, acceleration enrichment, full-load enrichment, fuel cut-off on the overrun, matching of the mixture to the operating point in the engine map, keeping idle speed constant, and generation of signals for external displays such as the trip computer.

The four-cylinder engines from the M 102 series corresponded to those in the 123 and 201 series, with the exception of some detail modifications: amongst other things, the rocker arms had hydraulic valve clearance elements instead of adjusting screws. The oil filter with access from above, whose expendable filter cartridge was bolted to the oil filter bottom, was also new. The 2.3-liter injection engine had electronic control for fuel cut-off on the overrun, full-load enrichment, and engine warm-up adjustment.

The success story of the M 102 engine family reflected the continuity of development at Mercedes-Benz: proven engines were constantly improved and new requirements were catered to. This long-term evolution was demonstrated in 1985 by the anniversary of the M 102: in December 1985, the one-millionth four-cylinder engine of this series came off the production line.

Four-valve technology for all gasoline-engined mid-series models

In 1989, the Mercedes-Benz 300 E-24 model was added to the 124 series. Its three-liter six-cylinder engine with four-valve technology debuted a few months earlier in the 300 SL-24. With a closed-look three-way catalytic converter, this engine with manifold injection developed 220 hp (162 kW) at 6400 rpm. At the Paris Motor Show in October 1990, Mercedes-Benz then presented the new top-of-the-line model in the model series, the 500 E. It had

a five-liter V8 four-valve engine that developed 326 hp (240 kW) at 5700 rpm, which was based on the proven engine of the 500 SL. This engine afforded the
E-Class breathtaking performance: with the four-speed automatic transmission fitted as standard, the car reached 100 km/h from standstill in 5.9 seconds, while the top speed was cut off electronically at 250 km/h. In order to reduce emissions, the volume of the double catalytic converter was increased from 3.9 to 5.8 liters, assisted by secondary air injection and exhaust gas recirculation.

In the 500 E, a new variant of the four-valve V8 was used for the first time that differed from the model known from the SL in that it not only had a different injection system, but also a modified crankcase. Instead of the mechanically and electronically controlled Bosch
KE-Jetronic, the electronically controlled Bosch LH-Jetronic with air mass sensor was used for the first time. There were even more radical changes to the engine block, which now had the same cylinder deck height as its smaller sibling with a 4.2-liter displacement in the 400 E. The new engines with uniform cylinder deck height were thus more economical to manufacture.

When, in September 1992, Mercedes-Benz presented a revised model range for the mid-series, the gasoline engine models had undergone particularly extensive modification. Amongst other things, the engine range had been completely converted to four-valve technology – M 111 four-cylinder engines with two and 2.2-liter-displacement replaced the two-valve versions from the
M 102 engine family. The new engines featured increased output and a higher torque over the entire engine speed range, and yet it was still possible to reduce the fuel consumption. Owing to an

increase in the catalytic converter volume, a reduction in pollutant emissions was also obtained. The new M 111 gasoline engine series with four-valve technology turned out to be just as successful as the M 102: by 1999, the two-millionth M 111 engines had already come off the production lines at the Untertürkheim plant. Amongst other things, this engine was also the technological basis for the reintroduction of the supercharger.

The noise level of this new sixteen-valve unit was significantly reduced compared with the earlier sports-car engines with four valves per cylinder. The rapid combustion was rather harsh in engines of this type, which resulted in a louder noise than in comparable two-valve engines. In a sports context, this characteristic sound was prized as a hallmark of powerful engines.

For volume production, however, Mercedes-Benz refined the four-valve engines. For this purpose, almost every part was examined by the engineers from the point of view of acoustics. At engine speeds up to 6,000 rpm, particularly flexible valve springs were used, the rigidity of the casing was improved and the internal friction reduced. "*Smooth running is the order of the day*," announced a 1992 press release. The two-liter four-cylinder with a fully electronic injection and ignition system controlled by means of the manifold pressure developed 136 hp (100 kW) at 5500 rpm and a torque of 190 Newton meters at 4000 rpm. The 2.2-liter four-cylinder engine had an air-mass-controlled, fully electronic injection and ignition system with hot-film air-mass sensor via a sensor plate. It developed 150 hp (110 kW) at 5500 rpm and a torque of 210 Newton meters at 4000 rpm.

Two new four-valve engines with 2.8 and 3.2-liter displacement took over as successors of the two two-valve six-cylinder and the three-liter four-valve engines. Like the previous engine of the 300 E-24, they in fact belonged to the M 104 engine series; however, they were characterized by a modified bore/stroke ratio. All four- and six-cylinders now had the same bore: this was an advantage that allowed more flexible and more economical manufacturing.

The new 2.8-liter engine outperformed the two-valve engines from the M 103 family in terms of output and torque, without having higher fuel consumption. In the 3.2-liter variant, which had already proven itself in the S-Class, the rated output compared with the previous three-liter four-valve unit may have remained the same, but it was attained 900 rpm earlier. The maximum torque was considerably higher and was likewise generated at lower engine speeds. The 2.8-liter six-cylinder developed 197 hp (145 kW) at 5500 rpm, and had a torque of 270 Newton meters at 3750 rpm. The 3.2-liter six-cylinder generated 220 hp (162 kW) at 5500 rpm, and had 310 Newton meters torque at 3750 rpm.

Both six-cylinders had hot-film air-mass sensors and a variable-resonance intake manifold for an improved torque curve. At low engine speeds, a pneumatically controlled flap allocated the intake volume to two groups of three cylinders each. This created the effect of a “double three-cylinder” that used the consistently high charging effect. At higher engine speeds in excess of 4000 rpm, this mechanism switched itself off again.

The 400 E appeared at the same time as the refined models of the mid-size class. This new model, which was the top-of-the-line amongst the volume models, was fitted with the 4.2-liter V8 with four-valve technology used in the S-Class, and developed 278 hp (205 kW) at 5700 rpm. With four-speed automatic transmission as standard, the 400 E reached 100 km/h from standstill in 6.8 seconds, and the top speed was electronically limited to 250 km/h, as in the 500 E. The exhaust system with exhaust gas recirculation, secondary air injection, and large-volume catalytic converter also corresponded to that of the 500 E.

Second-generation catalytic converter vehicles

In 1985, at the Frankfurt International Motor Show, Mercedes-Benz presented an improved and expanded passenger car range. The second generation of the catalytic converter vehicles shown here offered higher pollutant conversion levels with less aging of the catalytic converter. All engines of the automobiles shown were designed for operation with premium unleaded gasoline. Because this gasoline was not, however, available at every filling station, the catalytic converter vehicles could also refuel with unleaded regular-grade gasoline, thanks to the multi-functional mixture formation and ignition system (MF system).

A new feature was the fuel evaporation system, which channeled gasoline fumes out of the tank expansion reservoir into a reservoir with activated charcoal. The gases were collected there and fed back to the engine again. Another innovation in the V8 engines was the EZL electronic ignition system. The ignition point was calculated in the EZL based on engine speed, crankshaft position, engine load, and engine temperature, amongst other things.

Return of the 300 SL

In the SL family (R 107 series), Mercedes-Benz showed a completely revised model line-up at the 1985 IAA. And after a 22-year interval, the company once again launched a sports car on the market with the magical model designation 300 SL. The 300 SL was powered by the newly developed three-liter six-cylinder M 103 E 30 engine. Generating 188 hp (138 kW) at 5700 rpm (180 hp/132 kW with a catalytic converter), the 300 SL became the new entry-level model of the updated 107 series.

Also new to the range was a 4.2-liter V8 which was created by enlarging the displacement of the 3.8-liter engine, and which now replaced the latter in the SL, in the S-Class sedan, and in the SEC coupe. The five-liter engine was modified: it now had an electronic ignition system and the Bosch KE-Jetronic electronically and mechanically controlled injection system. The most spectacular new unit in the engine range was a 5.6-liter V8, which was created by lengthening the stroke of the five-liter engine. However, the 560 SL was produced with a catalytic emission control system only for the export market. With a catalytic converter, the car developed 230 hp (170 kW) at 4750 rpm.

Innovations in four-valve technology

In 1989, in the new SL R 129 series, Mercedes-Benz presented the newly designed three-liter four-valve engine. The engine of the 300 SL-24 had been developed from the M 103; new features were the four-valve cylinder head and the map-controlled adjusting mechanism of the intake camshaft, which was being used for the first time by Mercedes-Benz. Along with higher compression and an electronic ignition system with anti-knock control, the four-valve M 104 developed 40 hp (29 kW) more output than the M 103 (190 hp/140 kW vs. 231 hp/170 kW). As a result, the performance of the 300 SL-24 was appreciably more dynamic with almost the same fuel consumption; however, this came with an additional price tag of just under 10,000 deutschmarks.

In particular, the cylinder head of the four-valve engine with its adjustable intake camshaft was completely redesigned. The valves arranged at an angle of 50 degrees were operated in each case by an intake and exhaust camshaft via maintenance-free hydraulic bucket tappets. An adjustment of the intake camshaft was realized in this engine for the first time in Mercedes-Benz history. The procedure allowed better filling of the cylinder, depending on engine speed and torque.

In the design of the cylinder heads, the engineers dispensed with the squish areas in the combustion chamber which up until then had been the norm. Compact, roof-shaped combustion chambers were thus produced with flat pistons and a central sparkplug arrangement. This intensified the combustion and reduced the emission of unburned hydrocarbons. This extremely dynamic engine featured a broad torque band, and its combined mechanically and electronically operated fuel injection system was also used in the V8.

The basis for this V8 with four-valve technology and five-liter displacement (M 119 E 50) was the five-liter engine from the S-Class. Completely redesigned cylinder heads now had a total of 32 valves and four camshafts. The arrangement of the exhaust valves allowed a narrow overall engine width. The 326-hp (240-kW) engine made the 500 SL the most powerful Mercedes-Benz production car: from a standstill, the top-of-the-line model accelerated to 100 km/h in 6.2 seconds, with a top speed that was electronically limited to 250 km/h.

The pivotal factors in the significant gain in output and torque were, in addition to the conversion to four-valve technology and the adjustable intake camshaft, the anti-knock control, a new two-plate air filter with reduced suction resistance, and, not least, modifications to the emission control system: like the two six-cylinder engines, the four-valve V8 were fitted with a double catalytic converter with a larger cross-section, and the pre-catalytic converter was omitted.

The carburetor era comes to an end

- **The 190 E 1.8 replaces the last Mercedes-Benz car with carburetor engine in 1990**
- **In the 600 SE, a V12 is used for the first time in a Mercedes-Benz passenger car**
- **Innovative engine design reduces consumption with various specific solutions**

36 years after Mercedes-Benz first implemented gasoline injection in a production car – the 300 SL – with four-stroke engine, the Stuttgart brand brought the era of passenger cars with carburetor engines to an end. In 1990, Mercedes Benz presented the new 190 E 1.8 model with 1.8-liter injection engine at the Turin Motor Show. In the 201 series, it replaced the previous carburetor model 190. At the same time, the 200 and 200 T carburetor models were no longer used in the mid-sized 124 series, so that, from the end of April 1990, the passenger car sales range comprised only vehicles with injection engines.

Return of the V12

In December 1990, Mercedes-Benz announced the "*beginning of a completely new age of engineering*" at the presentation of the newly developed V12 engine. The new M 120 E 60 had the cylinder bank angle (60 degrees) and four-valve technology in common with its almost 70-year-old forefather from the W 154 racing car. The, displacement, however, had doubled since the Silver Arrow era, and, in addition to output and torque, the demands on environmental compatibility had also increased. In this engine, which was first used in the C 112 experimental car in 1990, and which had its production launch in the new Mercedes-

Benz 600 SE (W 140) in 1991, the engineers therefore minimized emissions and reduced consumption. An exhaust gas recirculation system already significantly reduced nitrogen oxide formation in the engine even with just a small amount of exhaust gases in the intake air.

A total of 48 valves with 96 valve springs, which opened and closed up to 3,000 times per minute – from a mechanical perspective alone, the V12 made extremely high demands on its design. Nevertheless, the six-liter engine was convincing, thanks to its complete suitability for everyday use with no limitations, its excellent smooth running characteristics and high flexibility. The engine developed its maximum output of 408 hp (300 kW) at 5200 rpm, and a maximum torque of 580 Newton meters was achieved at approximately 3800 rpm.

For the purposes of engine management, and for the first time ever in vehicle development, a networking of the electronic control units by means of bus technology was achieved. The individual components of the engine electronics were, as in teleconferencing, engaged in a continuous data exchange with one another. In the case of the new V12, this involved electronic ignition for each cylinder bank, two electronic injection systems with air mass sensors, the electronic air management ("electronic accelerator") system, and acceleration skid control (ASR, including ABS). The CAN (Controller Area Network) databus allowed communication between these control units. This, in turn, afforded greater efficiency and operational reliability, and also created the possibility of new functions (for example, catalytic converter heating). The individual computers formed an intelligent overall system in which each component could contribute its own abilities to the fullest extent. The engine management even affected the traction: engine friction torque control (MSR) responded to slip at the rear wheels caused by load changes and stabilized the vehicle by opening the throttle valve – in this way, the braking torque of the engine was reduced.

A new feature in the V12 engine was the fully electronic injection system with hot-wire air-mass sensor (HLM), which replaced the throttling flap that governed air mass pressure. The injection of the gasoline took place upstream of the closed intake valve. The fuel thus evaporated before the intake, which resulted in very good mixture formation and almost complete combustion of the gasoline. Depending on the load, the injection process was ended before the opening of the valve (partial load), or gasoline was also injected into the opened intake tract (full load), in order to achieve greater filling of the cylinder. The fully electronic ignition of the fourth generation calculated the optimal ignition point from a data record that took account of coolant temperature, engine speed and intake manifold vacuum. This occurred individually for every cylinder via cylinder-selective ignition maps.

While the V8 engines of the new S-Class with four- and five-liter displacement were refined versions of existing ones, the new 3.2-liter six-cylinder in-line engine of the Mercedes-Benz 300 SE was based on the V12. In order to create a coordinated production network between the V12 and six-cylinder in-line (M 104) engines, the right-hand cylinder head of the V12 matched the cylinder head of the six-cylinder in-line unit. Bore x stroke of the six-cylinder was 89.9 x 84 millimeters; it developed 231 hp (170 kW) at 5800 rpm, and the maximum torque was 310 Newton meters at 4100 rpm.

Model designations change with the new C-Class

When Mercedes-Benz presented the new compact sedan of the C-Class (202 series) in May 1993, new, consistent model designations for all of the brand's passenger cars were also introduced. From then on, an initial letter or a letter combination would indicate the class to which the car belonged, followed by a figure for engine displacement. Many of the earlier letters or numbers that had served to identify engine and bodywork variants were now dispensed with once and for all. The reason for this reform was demonstrated by C-Class: all the gasoline engines used in the W 202 were injection engines with four-valve technology. Distinguishing these from two-valve or carburetor versions was thus no longer necessary.

The four-cylinder engines of the 202 series all belonged to the M 111 engine family. In the design of the engines, the engineers favored high tractive power rather than the greatest output. Like all current four-valve units of the model range, the four-cylinder in-line engines were equipped with a rotorless high-voltage distributor which had no movable parts, thus preventing associated wear. Double spark coils on the intake manifold supplied two cylinders in each case.

The newly designed M 111 E 18 engine developed 122 hp (90 kW) at 5500 rpm from 1.8 liters, and achieved 170 Newton meters torque at 4200 rpm. The two-liter M 111 E 20 engine generated 136 hp (100 kW) at 5500 rpm, and had a torque of 190 Newton meters at 4000 rpm. The 2.2-liter engine developed 150 hp (110 kW) at 5500 rpm and had a torque of 210 Newton meters at 4000 rpm. In 1996, the latter was replaced by the 2.3-liter M 111 E 23 engine (150 hp/110 kW at 5400 rpm) in the C 230. Finally, the proven 2.8-liter six-cylinder engine in the C 280 developed 193 hp (142 kW) at 5500 rpm with 270 Newton meters torque at

3750 rpm. Its consumption was lower than in the Mercedes-Benz 190, despite a higher output.

The 2.2-liter engine had a device for adjustment of the intake camshaft. Mercedes-Benz had used this technology since 1989, in order to stabilize engine running. Like the 2.8-liter six-cylinder in-line unit, the engine also had anti-knock control to compensate for variations in the octane ratings.

New six-cylinder in-line engines for the SL-Class

In 1993, Mercedes-Benz presented two new six-cylinder in-line engines with four-valve technology in the SL 280 and SL 320 from the SL 129 series. They replaced the previous six-cylinder 300 SL and 300 SL-24 models. Both engines operated with a variable-resonance intake manifold. The characteristics of the six-cylinder in-line engine were thus transmitted into two three-cylinder engines by means of a pneumatically controlled flap.

This action of the variable intake manifold was supported by the variable control of the intake camshaft. The engine of the SL 280 developed 193 hp (142 kW) at 5500 rpm and provided 270 Newton meters torque at 3750 rpm. The SL 320 generated 231 hp (170 kW) at 5600 rpm, with 315 Newton meters torque at 3750 rpm.

Innovations in engine design from A to G

In the same year, the company also presented the Vision A 93 concept study at the Frankfurt International Motor Show, the forerunner of the A-Class. The C 36 AMG was also shown as the top-of-the-line model in the C-Class. The 3.6-liter six-cylinder engine developed by AMG delivered 280 hp (206 kW) at 5750 rpm.

Also premiered was the G 320 offroader which was equipped with the 3.2-liter four-valve M 104 E 32 engine already used in the E- and
S-Class. The G 320 replaced the G 300 in spring 1994. At the same time, in March 1994, Mercedes-Benz presented the S-Class of the 140 series which had been upgraded in terms of its styling and technology. While these refinement measures mainly concerned the design, in September 1995 technical improvements were realized in the eight-cylinder and twelve-cylinder models of the W 140. A completely newly developed five-speed automatic transmission with torque converter lockup clutch, which had already been used in the S 600 coupe since May 1995, now also replaced the four-speed transmission with hydraulic control used in the sedans up until then. The core feature of the automatic transmission was electronic transmission control which quickly and automatically adjusted the gearshifts to every driving situation, and which was engaged in a permanent exchange of data with the electronic engine management.

The engines were again revised in order to further reduce fuel consumption and pollutant emissions. For this purpose, the two V8 engines were fitted with a modified crankshaft, an optimized valve control linkage, pistons with reduced weight, dedicated ignition coils for each cylinder, and improved electronic engine management – the Motronic ME 1.0 – in which a hot-film air-mass sensor was integrated instead of the hot-wire air-mass sensor that had been used until then.

The design modifications to the V12 engine were less significant, and concerned only the ignition coil arrangement and the electronic engine management. As a result of the various modifications to the engine and the use of the new automatic transmission, it was possible to reduce the fuel consumption of the V8 and V12 models, with no change in power output, by an average of seven percent, and pollutant emissions were even reduced by more than 40 percent.

In 1995, fuel savings of approximately ten percent were also achieved by the engineers for the engines of the SL-Class in the SL 500 (V8) and SL 600 (V12). Amongst other things, the eight-cylinder was fitted with an improved crankshaft, an optimized valve control linkage, dedicated ignition coils for every combustion chamber, and the new Motronic ME 1.0 engine management.

New home for V-engines

On May 5, 1994, Stuttgart's Lord Mayor Manfred Rommel and Jürgen Hubbert, member of the Mercedes-Benz Board of Management with responsibility for the Passenger Car Division, signaled the start of construction of the production plant for the new generation of V6 and V8 engines in Stuttgart-Bad Cannstatt with a ground-breaking ceremony.

In April 1997, the new V-engine plant was officially opened in the presence of Baden-Württemberg' Minister President Erwin Teufel. This Factory of the Future, in which more than 300,000 V6 and V8 engines were to be produced each year using the most up-to-date manufacturing methods, focused to a large degree on environmentally sound technology. At the heart of the design of the new location was the efficient manufacture of the six- and eight-cylinder engines on the same machinery. This meant that many components were used that were developed with the same design features, making it possible to significantly reduce component diversity.

In November 1997, only seven months after the official opening and one year after delivery of the first engine to a customer, the 100,000th engine of the V6/V8 M 112/113 series came off the production line in the new V-engine plant. Just a year and a half later, the Bad Cannstatt employees were already completing the 500,000th V-engine of the M 112/113 series, and in May 2000 the one-millionth V6/V8 engine left the production line.

New E-Class: Low emissions and smooth running

In 1995, in the new E-Class of the 210 series, Mercedes-Benz presented a newly developed 2.3-liter engine developing 150 hp (110 kW) in the E 230. The additional output of the engine derived from the 2.2-liter four-cylinder was mainly generated in the lower and middle engine speed range: the engine delivered 220 Newton meters torque between 3700 and 4500 rpm.

The gasoline engines of all the displacement classes in the 210 series were provided with four-valve technology at this time. They featured a high torque and great tractive power over a wide speed range. They also had low emissions and smooth running characteristics. These advantages were obtained thanks to complex technology that also included the air-mass-controlled, fully electronic injection and ignition system (HFM engine management).

The four-valve six-cylinder engines, as reference models for their class, to a large degree matched the engines of the predecessor series. In the new M 119 E 42 engine – a V8 unit with Motronic ME 1.0 – in the E 420, emissions and consumption were reduced still further as compared with earlier V8 engines. In the E 420, engine power was transferred to the road by a newly developed five-speed automatic transmission.

Compressed air boosts output in the C-Class

In 1995, the Mercedes-Benz design engineers reconsidered the legendary engines with mechanical superchargers. The renaissance of this technology in passenger cars began with the 2.3-liter four-cylinder C-Class, SLK and CLK engines. At the 1995 IAA, the C 230 KOMPRESSOR was presented, whose maximum torque of 280 Newton meters was available in the engine speed range between 2500 and 4800 rpm thanks to mechanical supercharging. However, the 193-hp (142-kW) four-valve four-cylinder engine consumed only 8.2 liters of premium gasoline on 100 kilometers in a Euro-Mix. The engine was thus approximately one fifth more economical than a naturally aspirated engine of the same power output.

In the C 230 compressor, the mechanical charger forced a good liter of air in the direction of the engine with every rotation of its blades. The supercharged C-Class accelerated from standstill to 100 km/h in 8.4 seconds and from 60 km/h to 120 km/h in 11.8 seconds. The top speed was approximately 230 km/h. With this car, Mercedes-Benz followed on from the tradition of Daimler-Motoren-Gesellschaft: in 1918, DMG had successfully used a supercharger for the first time in the aircraft engines developed by Paul Daimler, while in 1922, the first supercharged Daimler car competed in the Targa Florio in Sicily. The mechanical supercharger subsequently characterized the Mercedes and Mercedes-Benz racing cars and sports cars in the 1920s and 1930s.

In its 1995 renaissance, the technology combined high torque with good fuel economy and low emissions. The engineers explained the effect of the supercharger using a comparison, saying that supercharged engines combined the tractive power of a six-cylinder engine with the economy of a four-cylinder engine.

The reintroduction of the supercharger occurred after careful consideration of two different methods of charge air compression; in the end, the designers favored mechanical supercharging by means of a Roots blower over turbocharging by means of an exhaust gas turbocharger. The reason for this was that, in gasoline engines, the supercharger offers a range of advantages: in particular, these include the more rapid response of the supercharger, which spontaneously and evenly builds up the charge pressure. The turbo lag resulting from a delayed response when using exhaust gas turbocharging does not occur. The reason for this is the direct mechanical connection of the supercharger to the engine, while the turbocharger speed is increased only by the changed exhaust gas flow. In the 1995 engine, emission control was carried out by modern catalytic converters with a tri-metal coating.

In addition, the Mercedes-Benz engineers made out improved emissions characteristics for the supercharger, because it was not integrated into the exhaust system and thus did not affect exhaust gas temperatures. Roots blowers with three-blade rotors were used as superchargers, the blades of which were coated in plastic. These rotors rotated in a contactless manner at up to 12,000 rpm.

However, owing to the extremely narrow clearance between the rotors, a very high delivery rate was possible even at low engine speeds. The effect of the supercharger was improved by means of charge-air cooling which was arranged crosswise behind the supercharger; because the cooler air has a greater density, the engine is able to process greater air volumes.

Launch of the Mercedes-Benz V6 engines

In 1997, at the RAI Motor Show in Amsterdam, Mercedes-Benz presented vehicles with V6 gasoline engines. The E 280 and E 320 had completely newly developed engines which significantly undercut even the world's strictest emission standards applicable at that time. Mercedes-Benz thus prepared its vehicles for the stricter emission regulations that were expected in the future.

While the ideal cylinder bank angle of V6 engines was normally 60 degrees, in the new design the engineers opted for the 90-degree angle of the V8 engines. A balancer shaft, which rotated in the opposite direction to that of the crankshaft, nevertheless provided silky-smooth running in the new V6. The fuel consumption fell by up to 13 percent compared with the previous six-cylinder in-line engines which had been built since the end of 1984. With this ultra-modern engine concept, Mercedes-Benz thus brought together the values of motoring pleasure, ecology, and economy.

While fuel consumption fell, the efficiency of emission control was increased in these engines to more than 97 percent. The origins of this improvement were explained by Helmut Petri, in 1997 deputy member of the Mercedes-Benz Board of Management and responsible for Passenger Car Development: this exemplary ecological balance was principally attributable to three-valve technology and dual ignition. This was because, in dual ignition, the sparkplugs were ignited individually and at intervals to optimize the combustion process in accordance with the operating mode of the engine. Additionally, thanks to three-valve technology, the catalytic converter reached its operating temperature much more quickly.

For the three-valve engines, Mercedes-Benz used two intake valves and one exhaust valve. The exhaust valve was sodium-cooled and had a 41-millimeter diameter. Because of the reduction to just one outlet, the heat loss in the exhaust gas flow was reduced, which meant that the catalytic converter achieved full efficiency after just 60 to 80 seconds. This was the prerequisite for satisfying emission control requirements at the time. Hans Karl Weining, head of Combustion in Engine Testing, had this to say with respect to the new V-engine project of Mercedes-Benz AG in 1997: because the catalytic converter had to convert hydrocarbons, nitrogen oxides and carbon monoxide with an efficiency of significantly greater than 90 percent, a quick start to the catalytic process was essential.

The engine as an element of passive safety

The engine and transmission took on a special role in the Mercedes-Benz A-Class presented in 1997, because the underfloor drive unit arranged at an angle in front of the pedal floor was an integral component of the safety concept together with the vehicle's sandwich floor. The drive system arranged in front of and under the intermediate floor slid along an inclined bulkhead under the passenger compartment in the event of a frontal impact. This reduced the risk of injury to the vehicle occupants.

Mercedes-Benz had to break new ground in the development of this drive system. This was because the engine and transmission of the
A-Class were, unlike in any other automobile up to that time, elementary components of the spatial and safety concept. The dimensions, and in particular the installation position of the engines, made traditional access to the assembly impossible, and called for a new design. The M 166 series was thus created, a completely new generation of four-cylinder engines with a light-alloy block. Initially, the gasoline engine versions A 140, developing 82 hp (60 kW), and A 160, developing 102 hp (75 kW), were available. The A 190, with its 125-hp (92-kW) M 166 E 19 engine, completed the model range in 1999.

Only the drive systems for the smart, another corporate brand, were even more compact than the engines of the A-Class: in summer 1997, production of the three-cylinder engine for the smart city coupe began in the Berlin-Marienfelde plant.

Innovative V-engines reduce consumption

The new V6 engines for the C-Class, which Mercedes-Benz presented in summer 1997, belonged to the generation of V-engines that were also used in the E- and M-Classes and in the CLK. The C 240, developing 170 hp (125 kW), and the C 280, developing 197 hp (145 kW), had modern gasoline engines with three-valve technology, dual ignition, and exhaust gas recirculation. This last feature alone led to a drop in fuel consumption of up to six percent.

In these engines, Mercedes-Benz introduced cylinder liners with silicon liner technology into production, and was the first motor manufacturer in the world to do so. These liners were no longer made from gray cast iron, but instead from an aluminum-silicon alloy with a particularly low-friction surface.

In September 1997, the new E 240 with a V6 engine replaced the four-cylinder E 230 that had been available up until then. The M 112 E 24 engine generated 170 hp (125 kW) at 5900 rpm. The advantages of the six-cylinder in terms of comfort compared with the predecessor model were appreciable. The top model position in the series went to the E 430 with a newly developed V8 engine (279 hp/205 kW at 5750 rpm) as the successor to the old V8 in the E 420. This M 113 E 43 featured still lower exhaust emissions, improved torque characteristics and better fuel economy. Consuming 11.3 liters of premium gasoline on 100 kilometers in the EU test cycle, the new engine was 11 percent more economical than its predecessor.

As in the V6, features of the new engine generation were three-valve technology and dual ignition, and also efficient lightweight design. The most important materials for this purpose were aluminum and magnesium. The use of these metals allowed weight reductions by more than 50 percent compared with engine blocks made of conventional gray cast iron. The cylinder liners were also manufactured from a new metal alloy that principally consisted of aluminum and silicon. Amongst other things, this provided less friction, better heat flow and greater dimensional stability in the casing. Owing to a cylinder bank angle of 90 degrees, the smoothness and comfort of the new V8 engines was very high; unlike the V6 engines at the time, these engines also did not require a balancer shaft.

V-engines for super sports cars and offroaders

In 1997, Mercedes-Benz presented the new high-performance CLK GTR sports car. The road-going racing coupe based on the CLK had a V12 mid-engine which, from a 6.9-liter displacement, developed 560 hp (412 kW) and achieved a maximum torque of 720 Newton meters.

The G 320 was also fitted with a new engine: its 215-hp (158-kW) V6 M 112 E 32 unit was employed in an almost identical design in the
M-Class, E-Class and in the CLK at the time.

The year of the eight-cylinder

For Mercedes-Benz, the 1998 season, or the "year of the eight-cylinder," began in January at the North American International Auto Show in Detroit. There, the company presented the ML 430 and CLK 430 models with V8 engines. The 279-hp (205-kW) engine made these two cars the top-of-the-line models in their respective series.

At the International Offroad Show in Munich in spring 1999, the Mercedes-Benz G 500 followed, with its V8 engine developing 296 hp (218 kW) at 5500 rpm. The M 113 E 50 engine was also the basis for the AMG version presented in 1999. The M 113 E 55 version of the eight-cylinder now developed 354 hp (260 kW) at 5500 rpm in the G 55 AMG. And finally, in the S 55 AMG S-Class model, the Affalterbach light-alloy engine with a displacement of just under 5.5 liters developed an output of 360 hp (265 kW) at 5500 rpm.

In 1999, the Vision SLR sports car study with a supercharged V8 engine developing 557 hp (410 kW) attracted much attention in Detroit as a gullwing coupe, and at the IAA as a roadster. In 2003, Mercedes-Benz presented the high-performance Mercedes-Benz SLR McLaren sports car developed from this study, which was equipped with a supercharged 626-hp (460-kW) V8 engine and accelerated from standstill to 100 km/h in 3.8 seconds. The SLR McLaren roadster followed in July 2007.

The V8 of the Mercedes SLR McLaren was the first eight-cylinder V-engine developed entirely by AMG. This high-torque engine achieved a good 600 Newton meters at 1500 rpm, 700 Newton meters at 2000 rpm and 780 Newton meters from 3250 to 5000 rpm. This engine combined high performance with the responsiveness of a true sports engine. A mechanical supercharger operating at up to 23,000 rpm provided excellent cylinder charge with up to 1850 kilograms of air per hour.

In the SLR 722 Edition – to commemorate the victory of Stirling Moss at the Mille Miglia in 1955 – the 5.5-liter V8 engine even developed 650 hp (478 kW). The engine of this special model, which was strictly limited to 150 units and presented in the summer of 2006, was built by hand, at the Mercedes AMG Engine Manufacture in Affalterbach, as is the case for every other engine in accordance with the "One man, one engine" principle.

Twelve comes up trumps

In 1999, some changes were made in the Mercedes-Benz range with regard to the V12 engines. The company presented the SL 73 AMG as a sporty high-performance model with an M 120 E 73 engine. The engine tuned by AMG developed 525 hp (386 kW) at 5500 rpm, with a displacement of 7.3 liters.

The new top-of-the-range S-Class model from the W 220 series was also presented with a V12 engine in 1999: in the S 600, the M 137 E 58 developed an impressive 367 hp (270 kW) at 5500 rpm.

Four-cylinder anniversary for the M 111

In December 1999, the two-millionth four-cylinder gasoline engine from the M 111 series was completed in the Untertürkheim plant. The engine, produced since 1992 and featuring four-valve technology, was used in models of the C-Class, E-Class, M-Class and CLK-Class, as well as in the V-Class and Sprinter. Also part of this engine family were the revised four-cylinder engines which Mercedes-Benz launched in 2000 for the station wagons of the C-Class, the sedans and station wagons of the E-Class, and the CLK coupes and convertibles.

CGI technology

In 2002, in the CLK 200 CGI, Mercedes-Benz presented a revolutionary generation of gasoline engines with direct gasoline injection based on the stratified-charge gasoline injection (CGI) principle. These direct gasoline injection engines had 16-percent lower fuel consumption than comparable engines with manifold injection. The microprocessor-controlled gasoline direct injection was combined with a hot-film air-mass sensor (HFM) and a mechanical supercharger.

Together with the new injection technology, a generation of four-cylinder engines was premiered and, thanks to their unique TWINPULSE system, set standards in this displacement category in terms of power development, torque characteristics, smooth running and fuel consumption. Two four-cylinder models were available: the CLK 200 KOMPRESSOR (163 hp/120 kW) with conventional fuel injection and the CLK 200 CGI (170 hp/125 kW) with direct gasoline injection. The TWINPULSE system was characterized by the combination of different technologies, which promised great motoring pleasure and a six-cylinder-like smoothness at low fuel consumption, namely balancer shafts, supercharger, charge air cooling, adjustable camshafts and four-valve technology.

TWINPULSE plus CGI

In the new CGI engine, Mercedes-Benz further enhanced the TWINPULSE system with innovative direct gasoline injection, which reduced the fuel consumption of the two-liter four-cylinder engine to just 7.9 liters per 100 kilometers (NEDC combined consumption). This was approximately 16 percent less than in the predecessor model. The reduction in fuel consumption in the C-Class presented in 2002 was even more significant: the direct gasoline injection of the C 200 CGI allowed fuel savings of more than 19 percent compared with the comparable predecessor model in the C-Class, in spite of the higher engine output of the new engine. On 100 kilometers, the new engine needed just 7.8 liters of sulfur-free, super plus gasoline (NEDC combined consumption). The direct injection engine provided more than 75 percent of its maximum torque of 250 Newton meters from an engine speed as low as 1500 rpm; the full torque was on tap from 3000 rpm and maintained constant up to 4500 rpm.

In this direct injection process, the combustion mixture was produced in the combustion chambers. The fuel was injected into the cylinders with the help of an injector at an angle of 42 degrees, and – depending on engine mode – at a pressure of 50 to 120 bar. There, the fuel droplets, together with the air particles, formed a mixture cloud which was carried to the sparkplugs by specially formed piston recesses. For the purposes of comparison: in the four-cylinder engine with conventional injection, the fuel pressure was approximately 3.8 bar.

To provide the mixture cloud with optimum swirl for the purposes of faster and complete combustion, the CGI engine had two separate intake ports whose flow characteristics were produced using a complex design. One of these intake ports was additionally provided with an adjustable swirl flap. The intake camshaft operated the high-pressure fuel pump; the pressure in the fuel line (rail), which was directly connected to the injectors, was regulated by a pressure governor controlled by the engine computer, which in turn received signals from a special pressure sensor.

A way towards the future of the gasoline engine

In the CLS 350 CGI, presented in 2006, the CGI method reaches a new level: the four-door coupe boasts the world's first gasoline engine with piezo direct injection and a spray-guided combustion process. The 292-hp (215-kW) six-cylinder engine of the CLS 350 CGI again attains fuel savings of approximately ten percent compared with the V6 gasoline engine with port injection. The new direct gasoline injection unit thus points the way forward for gasoline engines.

The rapid piezo injectors are among the most important components of the new direct gasoline injection system. They open their nozzle tips outwards and thus form an annulus of only a few micrometers, which shapes the fuel jet and ensures its uniform, hollow-cone-shaped propagation. Thanks to response times in the millisecond range, the piezo injectors allow even the multiple injections per working stroke required for lean-burn operation, and with this flexible and simultaneously efficient control of the combustion process they create an important precondition for exemplary fuel economy.

New four-cylinder engines

In 2002, Mercedes-Benz also presented a new generation of four-cylinder engines. These ultra-modern engines started off in the C-Class, and were also used in other Mercedes-Benz model series later on. The design focused on the reduction of fuel consumption, further improved torque characteristics, optimized power development and smooth running characteristics, as well as consistent use of lightweight design and other high-tech innovations. This underscored the role of the Mercedes-Benz C-Class as the technological leader in its market segment.

Turbocharging for V12 engines, A-Class and B-Class

All Mercedes-Benz twelve-cylinder engines were fitted with turbochargers in 2002. In order to compensate for the known disadvantages of exhaust gas turbocharging, the Mercedes-Benz engineers developed a complex solution. Thus, the V12 of the S 600 (W 220) operated with two exhaust gas turbochargers and one indirect intercooler. In the sedan, this M 275 KE 55 LA engine achieved a maximum output of 500 hp (368 kW) at 5000 rpm. The same engine was also used to power the SL 600.

Even more powerful was the AMG twelve-cylinder engine with biturbo in the new SL 65 AMG which Mercedes-Benz presented in 2004: developing 612 hp (450 kW) and 1000 Newton meters of maximum torque, this car was the production roadster with the highest output and torque in the world. The open two-seater not only added to the impressive V12 tradition of Mercedes-AMG, but also opened up new performance dimensions in this displacement class: it accelerated in 4.2 seconds from standstill to 100 km/h and after 12.9 seconds already attained 200 km/h, while its top speed was 250 km/h (electronically limited).

In 2005, turbochargers were also used in the two-liter models of the new Mercedes-Benz A-Class (W 169). The turbocharged 193-hp
(142-kW) engine was installed, like other engines, at a 59-degree angle behind the front axle. The A 200 TURBO model opened up new output dimensions for the A-Class, thanks to this engine. With a specific output of 96 hp (71 kW), the four-cylinder was among the most powerful engines of its displacement class. A maximum torque of 280 Newton meters was constantly available in a broad engine speed band up to 4850 rpm.

At the same time as the exhaust gas turbocharger was introduced in the A 200 TURBO, the engines of the A 150, A 170, and A 200 acquired increased displacement compared with the predecessor models as well as variable intake manifolds, which improved tractive power in the lower engine speed range. The AUTOTRONIC automatic transmission presented in the new A-Class operates according to the continuously variable transmission (CVT) principle, whereby the transmission is continuously adjusted via pulley variator and thrust link belt. The A-Class can therefore accelerate without interruptions in of tractive power.

The turbocharged engine of the A-Class is also used in the Mercedes-Benz B-Class (T 245 series). The Group has already been gaining experience in the turbocharging of gasoline production engines since 1998, with the engines of the smart.

Tailor-made six-cylinder for the new SLK

In 2004, for the first time in the car category, the new Mercedes-Benz SLK was fitted with a V8 engine in the SLK 55 AMG with an output of 360 hp (265 kW) at 5750 rpm. The six-cylinder engine of the SLK 350 model was, however, completely redeveloped for the roadster. With its exemplary performance and torque characteristics, this engine was perfectly suited to the dynamic sports car. The 3.5-liter four-valve engine set standards with a range of technological innovations in terms of fuel consumption and quiet running. However, the V6 developing 272 hp (200 kW) equally guaranteed dynamic motoring pleasure.

In 2004, in the 367-hp (270-kW) C 55 AMG, Mercedes-Benz also offered an eight-cylinder for the C-Class for the first time. In addition, a 192-hp (141-kW) four-cylinder with supercharger enhanced the engine range for the sedans and station wagons in the 202 series from the spring of 2004.

High engine speed concept and large displacement

An innovative concept – the combination of large displacement and high engine speeds – was realized by Mercedes-AMG in 2005 with a new V8 engine. The 6.3-liter V8 develops 510 hp (375 kW) at 6800 rpm. It is thus the most powerful naturally aspirated eight-cylinder engine in the world. In this engine, Mercedes-AMG combines huge displacement with the high engine speed concept (maximum engine speed at 7200 rpm). The configuration offers approximately 20 percent more torque than comparable engines of the same output class. The engine reaches its maximum torque of 630 Newton meters at 6800 rpm.

The engine is built completely from high-strength aluminum. The intake system is particularly complex with its vertical intake and exhaust ports and also a variable intake manifold with two internal, parallel-opening throttle valves. The engine has four valves per cylinder, which are actuated by means of bucket tappets. The coating of the cylinder liners in a procedure known as twin-wire arc spray coating is a world first. The surface thus produced has particularly low frictional losses. In its design, the V8 is a completely independent AMG development, without having parts in common with
Mercedes-Benz engines. This engine was incorporated in other Mercedes-Benz models at a later stage.

Shifting camshafts in the S-Class

In the S-Class, a new V8 engine was launched in 2005. The 5.5-liter engine develops 388 hp (285 kW), and was the new top-of-the-line engine in its engine family presented in 2004. The maximum torque of 530 Newton meters is on tap between 2800 and 4800 rpm. An innovative feature is the engine’s shifting camshafts; the variable camshafts compensate for pressure variations in the exhaust tract and thus ensure even smoother running of the eight-cylinder engine.

The six-cylinder engine in the S 350, developing 272 hp (200 kW) output, has variable camshafts with continuous adjustment. They also allow particularly fine tuning of the valve functions. This results in the optimum supply of the cylinder with fresh mixture, an improved gas cycle in the combustion chambers, and reduced loss of energy. The result: compared with its predecessor, the new engine saves one liter of fuel on 100 kilometers.

Finally, in 2006, the S 600 was launched on the market as the new top-of-the-line model. Its twelve-cylinder biturbo engine developing 517 hp (280 kW) has a maximum torque of 830 Newton meters, representing a considerable gain compared with the older version. While the current V6 and V8 engines feature four-valve technology, the new V12 has three valves per cylinder.

Technological innovations follow in the tradition of engine development in the past decades at Mercedes-Benz: "*More output with greater fuel economy*" was not merely the message of the S-Class of the W 221 series, since the combination of ecology and motoring pleasure thanks to innovative gasoline engines is a challenge for Mercedes-Benz, which the brand's researchers and engineers have successfully been meeting time and again over many years.

E-Class: more powerful supercharged engine and new V8

In April 2006, Mercedes-Benz presented the revised E-Class. The Mercedes-Benz engineers paid particular attention to the four- and eight-cylinder variants of the gasoline engines. The four-cylinder engine in the E 200 KOMPRESSOR delivered 12.5 percent more output than before: 184 hp (135 kW). At the same time, maximum torque rose to 250 Newton meters.

From mid-2006, a newly developed 5.5-liter eight-cylinder engine from the S-Class with an output of 388 hp (285 kW) was the new top-of-the-line engine for the E-Class. Compared with the previous V8, it delivered 26 percent more output. At 530 Newton meters the torque also comfortably exceeded the maximum for the preceding engine by around 15 percent. The new E 500 delivered the performance of a sports car: the sedan accelerated from 0 to 100 km/h in just 5.3 seconds, 0.7 seconds faster than the previous E 500.

DIESOTTO points the way into the future

The DIESOTTO research engine shown at the 2007 Frankfurt International Motor Show, which combines the advantages of the gasoline engine with those of the diesel engine plus those of hybrid technology, admirably follows in this tradition. It offers a combined power output of 258 hp (190 kW). With its novel controlled auto ignition (CAI), direct fuel injection and turbocharging, it combines the high power of the spark-ignition engine with the exemplary torque and great fuel economy of a diesel. The powertrain of the F 700 – a four-cylinder engine featuring two-stage charging – attains the performance level of a current S-Class car with a 3.5-liter naturally aspirated V6 gasoline engine or three-liter V6 turbodiesel. Its CO_2 emissions of a mere 127 grams per kilometer correspond to consumption of only 5.3 liters of gasoline per 100 kilometers (44.3 mpg), extremely low for a vehicle of this class.

Improved engines for the new C-Class

For the new C-Class (204 series) presented in 2007, Mercedes-Benz paid particular attention to further development of the four-cylinder engines. In the gasoline engine range, the output of the entry-level C 180 KOMPRESSOR increased from the previous 143 hp (105 kW) to

156 hp (115 kW), with maximum torque improved by 4.5 percent from 220 to 230 Newton meters, while the C 200 KOMPRESSOR develops 20 hp (15 kW) more than before. It has an output of 184 hp (135 kW) and generates its maximum torque of 250 Newton meters from 2800 rpm. These modified engines considerably improve the performance and fuel consumption of the four-cylinder models. When accelerating from standstill to 100 km/h, the C 200 KOMPRESSOR is 0.5 seconds faster than its predecessor. Improvements in fuel economy are equally impressive: the C 180 KOMPRESSOR consumes 0.3 liters per 100 kilometers less than before, while the combined fuel consumption of the C 200 KOMPRESSOR was reduced by 0.5 liters per 100 kilometers. The modern V6 engines in the C-Class remain unchanged.

Mercedes-Benz gasoline engines in research and motor sports

The models from S to SSKL were still used with the same engines in races and in private motoring. This very close relationship between racing engines and production engines changed in the 1930s at the latest, with the Mercedes-Benz Grand Prix cars known as the Silver Arrows and the contemporary record cars.

Later on, research vehicles were also still fitted with gasoline engines which were not directly carried over to production in this form. However, the lessons learned from research and motor sports were always of great importance for future developments in engine design at Mercedes-Benz.

The age of the Silver Arrows

The ability of the Mercedes-Benz engineers to continually improve their engine designs was demonstrated in a particularly striking manner during the Silver Arrow era. Silver Arrow was the name given initially to pre-war formula racing cars – models W 25, W 125, W 154 and W 165 – which dominated European racing from 1934 to 1939.

The era began with the W 25, whose engine with four valves per cylinder boasted two overhead camshafts and a supercharger. From 1934 to 1936, this car was constantly being modified and equipped with ever more powerful engines. The designers obtained the increases in output principally by increasing the displacement of the eight-cylinder engines. Starting from 3.4 liters and 354 hp (260 kW) at 5800 rpm, the output of the car had been increased to 4.7 liters and 494 hp (363 kW) at 5800 rpm by 1936

The W 125 presented in 1937 was the first Daimler-Benz racing car in which the supercharger was arranged behind the carburetors. Thus, the already prepared mixture was compressed, and not just the intake air. The eight-cylinder in-line M 125 F engine achieved 592 hp (435kW) at 5800 rpm with a 5.6-liter displacement, and the maximum engine speed was approximately 6000 rpm.

Twelve-cylinder engines for racing and records

For the new three-liter formula, which was implemented in 1938, Mercedes-Benz developed the W 154 racing car with a twelve-cylinder engine. A displacement of three liters for supercharged engines was specified in the regulations, while naturally aspirated engines were permitted to have a 4.5-liter displacement. Two mechanical Roots blowers supplied the V12 (cylinder bank angle 60 degrees) with compressed air, while two overhead camshafts per cylinder bank controlled the four-valve cylinders. The maximum output of the engine was 468 hp (344 kW) at 7800 rpm, while the continuous output achieved was measured at 454 hp (334 kW) at 7500 rpm. By using a two-stage supercharger, the engineers once again increased the output of the W 154 for the 1939 season. The M 163 engine developed a maximum of 483 hp (355 kW) at 7800 rpm.

In 1938, a supercharged V12 engine also powered the record car with which Rudolf Caracciola established the speed record of 432.7 km/h on the Frankfurt–Darmstadt motorway. This record achieved with a 5.6-liter engine stands to this day as the highest speed ever attained on a normal road.

The W 165 racing car of 1939, built especially for the 1.5-liter

formula, had a V8 engine. Like the V12 racing engines, the engine with a
90-degree cylinder bank angle had four valves per cylinder and two camshafts per cylinder bank. Supercharged by two Roots blowers, the engine developed a maximum of 254 hp (188 kW) at 8000 rpm, while the continuous output was 250 hp (184 kW) at 7900 rpm.

Mercedes-Benz 300 SL

The Mercedes-Benz 300 SL (W 194) was launched in 1952. The racy sports car with its characteristic gullwing doors was the first vehicle designed by Mercedes-Benz after the end of the Second World War specifically for motor sports activities. The design with a lightweight tubular steel frame on the modified chassis of the 300 model was by Rudolf Uhlenhaut. The six-cylinder in-line M 194 engine was installed at an angle of 50 degree to the left and with a three-liter displacement developed 175 hp (129 kW) at 5200 rpm. The engineers also experimented with a supercharger but finally opted for a naturally aspirated engine for the cars entered in racing.

Injection technology for Formula 1

When the 300 SL production sports car was fitted with a fuel injection system in 1954, the Stuttgart engineers also designed a particularly complex injection engine for the W 196 R racing car. This new Silver Arrow had a 2.5-liter eight-cylinder in-line engine that developed 256 hp (188 kW) at 8260 rpm. This direct injection engine was fed by a Bosch eight-plunger pump. One distinctive feature was the desmodromic valve control of the intake and exhaust valves by means of two overhead camshafts. This involved not only the opening of the valves by means of the camshaft, but also closing them. Valve springs were dispensed with.

Rotary piston four-stroke engines

The four-stroke cycle of Nikolaus Otto can be applied not only to reciprocating engines but also to rotary piston engines. The developments for this technology by Felix Wankel were pioneering. In order to investigate this method, Daimler-Benz AG signed a license contract with NSU in October 1962.

Rotary piston technology was developed extensively by Mercedes-Benz in subsequent years. The C 111 experimental car with a 280-hp (206-kW) three-rotor Wankel engine and plastic bodywork, which was presented in 1969 at the Frankfurt International Motor Show, attracted much attention. The Mercedes-Benz Wankel engine reached production standard in further stages of development of the C 111 of 1969 and 1970. The high fuel consumption of the rotary piston engine was, however, a disincentive to large-scale production.

Research for environmental protection

In the 1960s, the engineers were becoming increasingly conscious of environmental considerations. In particular, catalytic emission control of gasoline engines became the subject of intensive research at Mercedes-Benz at that time. Amongst other things, one reason for this was the strict emission standards in the USA, especially in California. In 1985, this research led to the presentation of a range in which all Mercedes-Benz models with gasoline engines were also available with catalytic converters.

Then, in the 1970s, research into alternative fuels was gaining ever-greater significance. In contrast to the alternative drive concepts, which were a complete break from the concept of the internal combustion engine, the Mercedes-Benz engineers continued to focus on the proven gasoline engine in these tests. Amongst other things, its operation with natural gas, alcohols, and various gasoline-alcohol mixtures was intensively researched. In 1979, for example, a fleet of 80 Mercedes Benz test cars took part in a large-scale test as part of the Alternative Drive Systems project sponsored by the Federal German Ministry of Research and Technology. This also involved testing the use of the M 15 fuel, a mixture of 85 percent premium gasoline and 15 percent methanol.

In 1980, test passenger cars were released that could be refueled with pure methanol or ethanol. Then, in 1992 at the Geneva Motor Show, Mercedes-Benz presented a Flexible Fuel test vehicle that was based on the 300 SE (W 140), whose engine management was designed for variable gasoline-methanol hybrid operation up to a methanol content of 85 percent. Vehicles with a natural gas drive system went into production at a later stage.

Reducing consumption with intelligent cylinder shut-off

In the 1970s, Mercedes-Benz engineers were already working on innovative technology for reducing fuel consumption. One such solution was selective cylinder shut-off when driving in the part-load range. In a V8 engine, two or four cylinders could be shut off.

Both the simple fuel shut-off and the valve shut-off have been extensively researched and developed by Mercedes-Benz as methods for reducing consumption since 1974. Neither of the shut-off stages resulted in a loss of comfort: the balancing of masses in a V8 was maintained in both four and six-cylinder operation. The benefits were a significant reduction in fuel consumption as a result of the fuel shut-off up to 120 km/h, while valve shut-off remained effective even up to 160 km/h.

When fuel cut-off occurred, two or four cylinders were shut down, which meant that no more mixture was supplied to them. As a result, the remaining cylinders obtained greater efficiency. This occurred in the lower part-load range in particular. In tests in city traffic, fuel savings of up to 20 percent were possible compared with V8 operation.

The valve shut-off went still further: electromagnetic actuators interrupted the connection between camshaft and valves, and, parallel to this, the fuel supply was shut off by means of solenoid valves. A gas cycle therefore did not take place in the cylinders.

Long-distance records and racing with four-valve technology

In 1983, Mercedes-Benz presented the 190 E 2.3-16. This car's gasoline engine was the brand's first to feature four-valve technology since 1914. The car initially proved its dynamism in record runs on the high-speed track in Nardo, Italy. In August 1983 Mercedes-Benz drivers set long-distance world records over 25,000 kilometers, 25,000 miles and 50,000 kilometers, respectively, at average speeds of almost 250 km/h with three near-production 190 E 2.3-16 cars.

The 190 E 2.5-16 also formed the basis for the Group A racing sport touring cars entered in the German Touring Car Championship (DTM). However, the existing engine did not meet the requirements for use in racing: it did not have the correct bore/stroke ratio, was not suitable for very high engine speeds owing to its undersquare nature, and had no capacity for increasing output. For these reasons, Mercedes-Benz decided to develop a completely new engine with the same displacement.

Another win at Le Mans

Two Sauber-Mercedes C9 racing sports cars won the 24-hour race at Le Mans in 1989. This double victory came 37 years after the first, and until that time, only success for Daimler-Benz at Le Mans. The racing cars were powered by the four-valve V8 M 119 HL engine with
five-liter displacement, developing 720 hp (530 kW) at 7000 rpm.

In the same year, the Mercedes-Benz V8 production engines were also successful: in September, the 500,000th V8 light alloy engine was built in Untertürkheim.

Return to Formula 1

In 1994, for the first time, the Sauber-Mercedes C13 started in the Formula 1 race in Interlagos, Brazil. With that, Mercedes-Benz as engine supplier for the Sauber Team returned to Formula 1 racing after 40 years. The 3.5-liter V10 four-valve engine weighed only 122.6 kilograms and developed a good 700 hp (515 kW). In October of the same year, Mercedes-Benz presented their new concept for Formula 1. The new partner was Team McLaren International which Mercedes Benz provided with the new three-liter V10 engines that had been developed in collaboration with the English Ilmor company.

In 1994, the Penske team also started with a Mercedes-Benz engine, a turbocharged 3.4-liter V8 engine, in the Indianapolis 500 race. After 200 laps, Al Unser Jr. won the race in the Penske Mercedes. In 1997, Mercedes-Benz as the engine partner for the Penske team won the manufacturers' championship in the CART World Series, the former IndyCar Series. The Bettenhausen, Forsythe, Hogan and Pac West customer teams also relied on the 800-hp (588-kW) V8 engine.

Research alliance for four-cylinder and hybrid technology

In 2002, DaimlerChrysler founded Global Engine Alliance L.L.C. together with Hyundai Motor Company and Mitsubishi Motors Corporation. This joint venture for the development and production of four-cylinder in-line gasoline engines was headquartered in the USA. In 2004, DaimlerChrysler and Hyundai Motor Company amended their strategic alliance. The joint development and production of a four-cylinder gasoline engine family, the so-called World Engine, was to be continued.

In September 2005, DaimlerChrysler signed a memorandum of understanding with BMW and General Motors Corporation for an alliance of equal partners for the development of hybrid drives.

Drive system technology for the future

In the 1990s, Mercedes-Benz had already researched gasoline engines for small vehicles that would consume less than two liters of gasoline per 100 kilometers. The small, innovative “Minmot” (working title) gasoline engine with minimal consumption and extremely low pollutant emissions was conceived as an intelligent alternative to expensive hybrid drives, and was based on the long experience of corporate research into gasoline engine technology.

It was not only the standards of the engine’s fuel consumption and emissions levels that were visionary; the Minmot was also to operate with hydrogen or methane gas, according to a provision in the specifications. In this way, the company sought to be able to react early on to future changes in the supply of fuels.

Similar objectives were pursued by the Lomix project in the late 1990s, although these were much more closely associated with production. The idea was to develop a concept for the C-Class that, thanks to modifications to aerodynamics, lightweight design, chassis and powertrain technology, consumed less than three liters of gasoline per 100 kilometers. The C-Class Lomix supplied the researchers with important findings for future vehicle concepts with extremely low consumption levels.

With these and other research projects, Mercedes-Benz is constantly redeveloping existing vehicle drive systems based on the gasoline engine – the contemporary example of this is the DIESOTTO research engine presented at the 2007 Frankfurt International Motor Show, which combines the advantages of gasoline engine technology with those of diesel engine technology. In this way, the brand, with its origins in the world's first-ever high-speed gasoline engines, is demonstrating its commitment to the future of the automobile.

Timeline: The history of the gasoline engine at Mercedes-Benz and its predecessor companies

1862: Nikolaus August Otto experiments with the model of a four-cylinder four-stroke engine.

1867: Otto's atmospheric gas engine wins approval at the World Exhibition in Paris ahead of other early internal combustion engines.

1876: Otto develops the four-stroke cycle. A first engine with pre-compression of the charge develops three hp (2.2 kW). In 1877, German Reich Patent No. 532 is granted.

1882: Gottlieb Daimler and Wilhelm Maybach resign from the Deutz engine factory and begin to develop their own engine in the greenhouse of Daimler's villa in Cannstatt.

1882: Hanomag seeks an annulment of Otto's four-stroke patent.

1883: Gottlieb Daimler and Wilhelm Maybach invent the high-speed gasoline engine. Daimler's uncontrolled hot-tube ignition allows an increase in engine revolutions by a factor of five compared with Otto's engine with flame ignition. The principle of the high-speed gasoline engine for vehicles can now be envisaged.

1884: Carl Benz begins development of his high-speed four-stroke engine for powering vehicles.

1885: Daimler and Maybach install their single-cylinder engine in the Riding Car. The engine already reaches engine speeds of 700 rpm and develops 0.5 hp (0.4 kW)

1885: Benz builds a four-stroke engine with electric ignition and incorporates it in his motor car.

1886: Benz patents his motor car. The water-cooled single-cylinder four-stroke engine of the automobile develops 0.75 hp (0.6 kW) at 400 rpm with a displacement of 954 cubic centimeters.

1886: Daimler's motor carriage is driven by a single-cylinder engine with a closed crankcase and hot-tube ignition. The engine, weighing only 40 kilograms, develops 1.1 hp (0.8 kW) at an engine speed of up to 900 rpm.

1888: Benz shows his motor car at the Engine and Working Machine Exhibition in Munich.

1889: Daimler builds vehicles with two-cylinder V-engines. The cylinders of the engine developed in 1888 are arranged as in the Grandfather Clock, as the first high-speed gasoline engine is called because of its looks. Both connecting rods act on a common crank bend.

1889: Panhard & Levassor buy licenses for the Daimler engine. This marks the birth of the French automobile industry.

1890: Wilhelm Maybach, working for Daimler, designs a first four-cylinder in-line engine developing five hp (3.7 kW) at 620 rpm, which is used in boats.

1893: Carl Benz develops a new engine ignition in which the primary circuit no longer remains permanently closed. This saves energy and allows ignition point adjustment.

1893: Maybach improves the mixture formation with the spray-nozzle carburetor.

1893: The 1000th gasoline engine is built at Benz & Cie.

1895: Daimler and Maybach, who resigned in 1891 following a disagreement, return to DMG. Maybach's Phoenix engine becomes the new drive system of Daimler vehicles. In the winter, Daimler builds the 1000th gasoline engine.

1897: DMG introduces the world's first four-cylinder production engine for use in vehicles. In 1889, the Daimler Phoenix Phaeton is the first model to be fitted with it.

1897: Benz develops a two-cylinder engine with pistons working in opposite directions. This "contra-engine" is the first horizontally-opposed piston engine.

1897: Maybach's tubular radiator improves engine cooling.

1897: Robert Bosch develops a new contact-breaking magneto ignition system.

1900: The engine of the 35 hp Mercedes is fitted with controlled intake valves.

1902: Benz & Cie. install in-line engines with two and four cylinders in the Benz Parsifal model.

1902: Ferdinand Porsche wins the Exelberg race with a Mercedes-Lohner-Porsche hybrid vehicle. The gasoline engine drives electric wheel hub motors via a dynamo.

1910: The engines of the Benz special touring car for the Prince Heinrich Rallies feature four valves per cylinder, driven by means of lateral camshafts.

1910: Daimler begins production of Knight sleeve valve engines for Mercedes automobiles.

1911: Three valves per cylinder (one intake valve and two exhaust valves) are used in the four-cylinder engine of the 37/90 hp Mercedes.

1914: Mercedes successfully uses four-valve technology in the engine of the Grand Prix car. The engine, with its high engine speed, becomes the standard for aircraft engines.

1914: The 21/50 hp Benz is the first Benz & Cie. passenger car with a six-cylinder engine.

1921: Mercedes introduces supercharger technology in production cars. The four-cylinder models are mechanically supercharged first, and then the six-cylinders. After 1926, Mercedes-Benz also adopts the supercharger for eight-cylinders and the engines of the Silver Arrow racing cars. Mechanical supercharging is a means of increasing output and of gaining prestige, and contributes significantly to the brand's image.

1924: The first Mercedes with an eight-cylinder engine is the supercharged Monza racing car (170 hp/125 kW at 7000 rpm, with a top speed of 180 km/h) designed by Ferdinand Porsche.

1926: The M 02 six-cylinder in-line engine is the first to be developed at Mercedes-Benz after the merger. The engine becomes the basis for several subsequent generations of gasoline engines.

1926: The Mercedes-Benz S model with a supercharged engine founds the dynasty of SS, SSK and SSKL sports cars. The W 06 series is used both as a powerful touring car and as a racing car.

1928: In the 18/80 hp Nürburg 460 (W 08), Mercedes-Benz presents the brand's first eight-cylinder gasoline engine in a passenger car.

1934: The Mercedes-Benz W 25 Grand Prix car is the first vehicle in the family of the legendary Silver Arrows. The racing cars with supercharger technology dominate European racing until 1939. Mechanically supercharged eight-cylinder in-line engines are used in the W 25 and W 125 cars, a supercharged V12 in the W 154, and a supercharged V8 in the W 165.

1934: The 130 (W 23) model is the first Mercedes-Benz production car to be equipped with a rear-mounted engine.

1951: The M 180 six-cylinder in-line engine of the 220 (W 187) is Mercedes-Benz's first new development after the Second World War.

1954: The Mercedes-Benz 300 SL (W 198 I) is the first production car with a four-stroke engine and fuel injection. The now-common direct injection is followed in 1957 with a manifold injection in the 300 d.

1957: The new M 121 engine family is launched in the cars with three-box body. Instead of valves at the side, the cylinders have overhead valves, and the lateral camshaft is replaced with an overhead one. The output is increased compared with the predecessor engine, while at the same time fuel consumption is reduced by one liter per 100 kilometers.

1958: The gasoline injection in the 220 SE model marks the change to large-scale production of this technology at Mercedes-Benz.

1960s: Catalytic emission control is investigated by Mercedes-Benz, spurred on in particular by strict emission standards in the USA, especially in California.

1961: Mercedes-Benz acquires a license for the Wankel engine. This rotary piston technology is developed to production standard in the C 111 research car (1969 to 1970).

1963: In the 600 (W 100) model, Mercedes-Benz presents a V8 engine for passenger cars for the first time, with a 6.3-liter displacement and developing 250 hp (184 kW) at 4000 rpm. The V8 of the 300 SEL 6.3, and also smaller V8 engines of the 1970s, are developed from it.

1969: Mercedes-Benz presents the spectacular C 111 experimental car with Wankel engine. The coupe is built in two stages of development with three- and four-rotor rotary piston engines. However, it does not reach large-scale production.

1970s: Mercedes-Benz tests the use of alternative fuels in gasoline engines.

1972: The new six cylinder in-line M 110 for the Stroke Eight (115/114 series) is launched with a 2.8-liter displacement in injection and carburetor versions, and has V-shaped overhead valves and two overhead camshafts.

November 1975: On the V8 engines of the S-Class (W 116), the electronically controlled Bosch D-Jetronic is replaced by the newly developed mechanically controlled Bosch K-Jetronic.

1976: The W 123 series is fitted with the new six-cylinder in-line M 123 engine. The four-cylinder in-line M 102, a completely new design, follows in 1980. It is designed for installation at a slight angle, in order to keep the overall height as low as possible. In spite of an increase in output of between 15 and 25 percent in the M 102, the fuel consumption in the W 123 declines by about ten percent. With the M 102, Mercedes-Benz abandons the joint production network for gasoline and diesel engines.

1979: The S-Class (W 126) with new V-engines arrives. Its light-alloy crankcase combines high output with low weight.

1981: Mercedes-Benz presents an energy concept that reduces the fuel consumption of six- and eight-cylinder engines. The reduction in consumption of the different Mercedes-Benz models with a gasoline engine is between three and 22 percent.

1983: Renaissance of four-valve technology in the Mercedes-Benz 190 E 2.3-16: the sixteen-valve engine (185 hp/136 kW at 6200 rpm) has four V-shaped overhead valves per cylinder, which are controlled by two overhead camshafts.

1984: In the 124 series, the new six-cylinder in-line engines from the M 103 series are premiered. The combustion chambers with squish areas allow higher turbulence in the cylinder and also the ignition of lean mixtures.

1985: New engines are launched for the S-Class. The top-of-the-line engine is the 5.6-liter eight-cylinder M 117 E 56. It develops 272 hp (200 kW) at 5000 rpm; a higher-compression model developing 300 hp (220 kW) is optionally available. At the time of their launch, the 560 SEL and 560 SEC models equipped with this engine variant are the most powerful production cars Mercedes-Benz ever built.

December 1985: The one-millionth four-cylinder engine of the M 102 series is built, testament to the long-lived development of this engine family and its success.

September 1986: Mercedes-Benz offers all gasoline-engined passenger cars with a closed-loop three-way catalytic converter fitted as standard.

1989: The new three-liter four-valve engine with map-controlled adjustment of the intake camshaft, first used by Mercedes-Benz in the 300 SL-24, provides a significant increase in output without raising fuel consumption. The adjustable intake camshaft is completely redesigned.

1989: Double victory for the Sauber-Mercedes C9 with a four-valve V8 in the Le Mans 24-hour race.

1990: The carburetor era comes to an end at Mercedes-Benz when the 190 E 1.8 model replaces the previous Mercedes-Benz 190.

December 1990: Mercedes-Benz presents the first V12 installed in one of their passenger cars: the M 120 E 60, with six-liter displacement, output of 408 hp (300 kW) at 5200 rpm, a 60-degree cylinder bank angle and four-valve technology. For the purposes of engine management, an electronic bus system is used for the first time in the 600 SE.

1992: The revised engine range of the mid-sized class now only includes gasoline engines with four-valve technology. The four-cylinder M 111 takes over from the M 102. The noise level of the four-valve engines is optimized for quiet, smooth running. The six-cylinder in-line M 104 is fitted with a variable-resonance intake manifold for an improved torque curve. At low engine speeds, a pneumatically controlled flap allocates the intake volume to two groups of three cylinders each, and the effect of a "double three-cylinder" is created for evenly high charging.

1994: Construction begins of the Mercedes-Benz V-engine plant in Bad Cannstatt, which is officially opened in 1997. V6 and V8 engines are produced there.

1994: Mercedes-Benz returns to Formula 1 racing as an engine supplier. Cars with Mercedes-Benz gasoline engines are also entered in the Indianapolis 500.

1995: The renaissance of supercharger technology in the M 111 (2.3-liter four-cylinder in C-Class, SLK and CLK) makes engines one fifth more economical than naturally aspirated engines with the same output.

1997: Mercedes-Benz produces V6 engines for the first time. The engines, with a 90-degree cylinder bank angle, are fitted with a balancer shaft for smooth running, which rotates in the opposite direction to the crankshaft. Three-valve technology (one sodium-cooled exhaust valve) ensures low emissions.

1997: The engines of the A-Class are part of the concept for increasing passive safety: in the event of a frontal impact, the engines slide underneath the passenger compartment.

1998: The "year of the eight-cylinder" at Mercedes-Benz. New V8 engines with a 279-hp (205-kW) output made the ML 430 and CLK 430 the top-of-the-line models of their series.

1999: The two-millionth four-cylinder of the M 111 series is built. Since its launch in 1992, the engine has been used in models of the C-, E-, M- and CLK-Class as well as in the V-Class and Sprinter.

2000: The one-millionth V-engine is built in Bad Cannstatt.

2002: All new Mercedes-Benz gasoline-engined passenger cars comply with the EURO IV emission standards effective from 2005.

2002: CGI engines with direct gasoline injection are introduced. The microprocessor-controlled direct gasoline injection is combined with a hot-film air-mass sensor (HFM) and a mechanical supercharger. CGI allows fuel savings of between ten and 19 percent compared with earlier engines.

2002: Turbocharging is introduced in all Mercedes-Benz twelve-cylinder engines. In 2005, the Mercedes-Benz A 200 TURBO and B 200 TURBO models also acquire this form of air charging. The technology has already been used for the corporate brand smart since 1998.

2002: A research alliance is founded by DaimlerChrysler together with Hyundai Motor Company and Mitsubishi Motors Corporation: Global Engine Alliance L.L.C. is intended to develop and produce four-cylinder in-line gasoline engines. Their objective is the so-called World Engine.

2003: Presentation of the Mercedes-Benz SLR McLaren with a supercharged 626-hp (460-kW) V8 engine. The drive system is the first eight-cylinder V-engine to be completely designed by AMG.

2004: The completely redesigned V6 in the new SLK 350 demonstrates exemplary output and torque characteristics and develops 272 hp (200 kW).

2005: Mercedes-AMG implements an innovative concept in the 6.3-liter V8: a large displacement together with a high engine speed (up to 7200 rpm) provides approximately 20 percent more torque than in comparable engines. The 510-hp (375-kW) engine built completely from high-strength aluminum is an independent AMG development that has no parts in common with Mercedes-Benz.

2005: The new 5.5-liter V8 in the S-Class has shifting camshafts. Adjustment of these allows compensation of pressure variations in the exhaust tract.

2006: The E-Class comes with revised engines. The four-cylinder unit in the E 200 KOMPRESSOR is more powerful without an increase in fuel consumption. The E 500 model is powered by the 5.5-liter V8 from the S-Class.

2007: The DIESOTTO research engine is shown at the Frankfurt International Motor Show. It combines the performance of the spark-ignition engine with the powerful torque and great fuel economy of a diesel.

2007: For the all-new C-Class, revised four-cylinder engines are available.

Further information from Daimler is available on the internet at:
www.media.daimler.com

About Daimler

Daimler AG, Stuttgart, with its businesses Mercedes-Benz Cars, Daimler Trucks, Daimler Financial Services, Mercedes-Benz Vans and Daimler Buses, is a globally leading producer of premium passenger cars and the largest manufacturer of commercial vehicles in the world. The Daimler Financial Services division has a broad offering of financial services, including vehicle financing, leasing, insurance and fleet management.
Daimler sells its products in nearly all the countries of the world and has production facilities on five continents. The company's founders, Gottlieb Daimler and Carl Benz, continued to make automotive history following their invention of the automobile in 1886. As an automotive pioneer, Daimler and its employees willingly accept an obligation to act responsibly towards society and the environment and to shape the future of safe and sustainable mobility with groundbreaking technologies and high-quality products. The current brand portfolio includes the world's most valuable automobile brand,
Mercedes-Benz, as well as smart, AMG, Maybach, Freightliner, Sterling, Western Star, Mitsubishi Fuso, Setra, Orion and Thomas Built Buses. The company is listed on the stock exchanges in Frankfurt, New York and Stuttgart (stock exchange abbreviation DAI). In 2007, the Group sold 2.1 million vehicles and employed a workforce of over 270,000 people; revenue totaled €99.4 billion and EBIT amounted to €8.7 billion. Daimler is an automotive Group with a commitment to excellence, and aims to achieve sustainable growth and industry-leading profitability.