STARTUNED®

Information for the Independent Mercedes-Benz Service Professional

March 2006 U.S. $6.00 € 12.50

Electrical Basics

ESP

Man Made Oil

Volume 6 Number 1

To Our Readers:

Welcome to *StarTuned*, the magazine for independent service technicians working on Mercedes-Benz vehicles. Mercedes-Benz sponsors *StarTuned* and provides the information coming your way in each issue.

Mercedes-Benz wants to present what you need to know to diagnose and repair Mercedes-Benz cars accurately, quickly and the first time. Text, graphic, on-line and other technical sources combine to make this possible.

Feature articles, derived from approved company sources, focus on being useful and interesting. Our digest of technical information can help you solve unanticipated problems quickly and expertly. Our list of Mercedes-Benz dealers can help you find original, Genuine Mercedes-Benz Parts.

We want *StarTuned* to be both helpful and informative, so please let us know just what kinds of features and other diagnostic services you'd like to see in it. We'll continue to bring you selected service bulletins from Mercedes-Benz and articles covering the different systems on these vehicles.

Send your suggestions, questions or comments to us at:

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StarTuned

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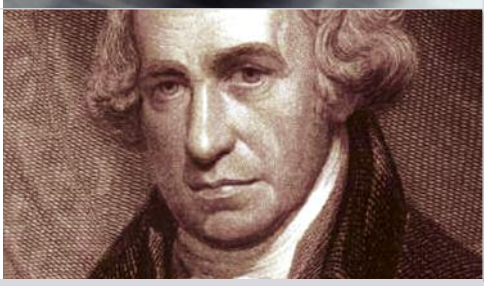

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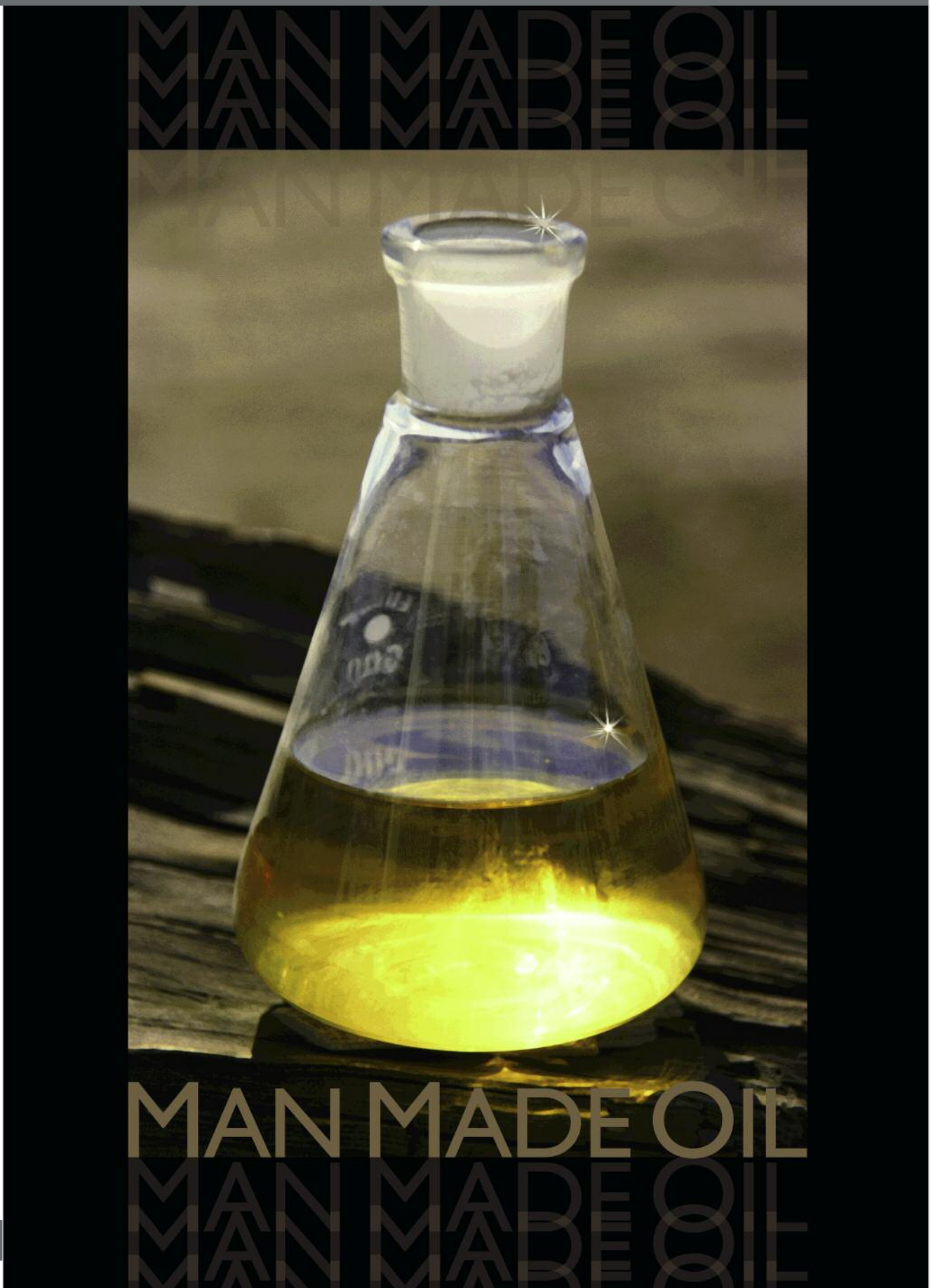

MAN MADE OIL

Mercedes-Benz wants man-made, not dinosaur-produced

If you've ever worried that the viscosity of synthetic oil is too thin to provide sufficient film strength, you can forget it. As the decal proclaims, this F1 car uses the most popular brand, and its engine operates at fabulous rpm for hours at a time.

In most cases, something real is better than something synthetic, but not for lubricating oils. The Mercedes-Benz Flexible Service System (FSS) calculates when oil changes should be done based on factors other than mileage alone, thus allowing change intervals to be extended. Since April of 2001, M-B has recommended synthetic liquid lubricant for all Mercedes-Benz vehicles, so we can all feel more comfortable with the longer intervals.

Mercedes was one of the first, but is not unique in using synthetics as its OEM oil. According to a Mobil 1 spokesman, 27 different cars now use his company's oil as the factory fill, including prestige nameplates such as Mercedes, Porsche, Bentley, and Corvette. The reason is simple: superior performance.

Oil can be evaluated using many different standards: viscosity consistency, anti-wear, anti-oxidation, and detergent properties are just a few of the tests done that apply directly to automotive engines. In every comparison, synthetics beat mineral- or petroleum-based oils.

Multi-viscosity synthetics can also be used at lower viscosity ratings than most petroleum based oils, which helps improve performance and fuel economy by reducing drag. This characteristic also allows it to get into bearings faster at low-temperature start-up (See Viscosity Basics Story). Mobil 1, for example, goes all the way to a 0W rating, and you can't get lower than zero. However, synthetics' superior performance comes with a higher price tag. Even at the heart-stopping prices that crude oil (the base for non-synthetic lubricants) reached and maintained since mid-2005, synthetics are still more expensive than

What's in your dispenser drum? Mercedes-Benz has recommended synthetic oil for all its vehicles since April of 2001. Petroleum-based oils simply cannot provide the lubrication and protection that current Mercedes-Benz engines require. You should use synthetic oil in all V6, V8, and V12 engines.

After more than 210,000 miles, this oil pan from a Mercedes E320 shows virtually no sludge. Synthetic oil was used exclusively, with 15,000 mile oil and approved filter change intervals (courtesy ExxonMobil).

conventional lubricating oil. The premium price is the only reason why synthetics haven't taken over the market. In fact, synthetics are estimated to account for only about five percent of engine oil sales. But their market share is growing as more people – shop owners, techs, and motorists alike – realize that the premium performance of synthetics justifies their higher price.

What oil does

Ask most people, including many technicians, what oil does and you will usually hear "lubricate" or "reduces friction" in reply. If that were entirely correct, engine oils would be simple to produce. But lubrication and friction reduction is only one of the jobs that motor oil must do. In addition, it must:

• Clean the engine by "capturing" contaminants and holding these microscopic particles in suspension until they can be removed by the oil filter, then eliminated during regular LOF service.

• Reduce the temperature of engine components by absorbing and redistributing heat.

• Provide a seal between the piston rings, their grooves and the cylinder walls as the piston travels up and down.

• Reduce engine wear by not only reducing friction, but also by absorbing the impact force placed on the connecting rod bearings and crankshaft rod journals when the piston changes its direction of travel.

As engine oil lubricates, cleans, cools, seals, and absorbs shock, it must also:

• Cling to the various surfaces to provide at least some lubrication and protection during start-up until normal oil pressure has built up and oil is flowing.

• Maintain viscosity (thickness) across a wide range of temperatures. If oil gets too thick when cold, flow will be inadequate during start-up in cold conditions resulting in rod knocks and accelerated bearing wear. If oil gets too thin when hot, it cannot maintain the film strength needed for adequate lubrication.

Synthetics accomplish all lubrication tasks better than petroleum oils because of the difference between the base stocks. Basically, molecules in a synthetic remain stable under a wider range of temperatures and pressures. Long after petroleum oil has failed due to heat and pressure, synthetic oil just keeps on flowing and providing protection.

More advantages

Synthetics also have other advantages over conventional oils:

• Synthetics have much less change in viscosity as temperatures change. The synthetic will flow more smoothly during cold start-up and will maintain viscosity for consistent lubrication as the engine reaches operating temperatures.

• Even at extremely cold temperatures (down to 50 below zero F.), low viscosity synthetic oil will flow. At those temperatures, conventional oils look like brown concrete that is starting to set up.

• Better high-temperature performance. The lighter chemical compounds in conventional oils will vaporize under high temperatures, causing increased oil consumption, decreased lubrication performance, and sludge formation. Depending on the viscosity grade, synthetics resist vaporization better.

• Synthetics tend to cling to engine parts after shut-down instead of completely draining down into the oil pan. The microscopic layer of synthetic oil on the surfaces of moving parts at start-up drastically reduces engine wear.

• Any oil will fail if it becomes oxidized, and every oil additive package contains oxidation inhibitors to increase service life. But these inhibitors are much more effective in a synthetic, which is one of the major reasons why synthetic oil can be safely used, under certain driving conditions, for 10,000 miles or more between changes.

• Because of their greater stability, synthetics cause fewer problems with sludge and other oil-related contamination. The high level of detergents in synthetics and the greater effectiveness of those detergents keep the engine cleaner than would be the case with ordinary motor oil.

Since the lighter fractions of synthetic oil don't flash off as readily as those of conventional oil, and because detergent additives work especially well with it, sludging is much less of a problem as long as the required oil and filter change interval is observed.

The base difference

Petroleum lubricants are among the many hydrocarbon products, along with diesel, gasoline, kerosene, etc., produced by distilling crude oil. After distillation, petroleum lubricants are further processed by removing solvents, waxes, sulfur and other impurities normally found in crude.

No oil, synthetic or otherwise, works alone. Both have complex additive packages to improve life, reduce friction, avoid oxidation, etc. After the base stock is completely refined, these complex additive packages are added to give the oil the performance characteristics required in modern internal combustion engines.

VISCOSITY BASICS

Viscosity is a measure of how readily or reluctantly a given oil will pour. In the United States, the Society of Automotive Engineers (SAE) established the test procedure to measure viscosity. The lower the number the easier the oil will flow because it is "thinner." A high viscosity number means the oil is "thicker." In cold weather, you want a lower viscosity so the oil will flow easily during start-up. However, as the engine temperature increases, you want a higher viscosity to resist oil film breakdown.

SAE has two viscosity test procedures. The winter viscosity value is measured at 0 degrees F. and has a "W" after the number (SAE 5W, 10W, or 20W). For the rest of the year, a high-temperature viscosity is tested at 210 degrees F. and has no letter behind it (SAE 20, 30, 40, and 50).

Very few single viscosity oils, conventional or synthetic, are sold today. Most oils, including all of the Mercedes Benz-approved synthetics, are "multi-viscosity", meaning that they are effective over a wide range of operating temperatures.

For example, a 5W-30 oil meets the SAE 5W standard for winter oil at 0 deg. F. It also meets the SAE 30 standard when tested at 210 deg. F. This oil will flow easily at low temperatures and will still provide full lubrication at normal operating temperatures.

Depending on the quality, an oil with a lower viscosity rating may reduce friction and parasitic drag, enabling engines to perform better and get better fuel mileage.

Synthetic oils use one of several man-made base stocks. Currently, four different base stocks are used: synthetic hydrocarbon, diesters, poly esters, and complex esters. For the purposes of this article, just naming those four is as far into the complex subject of synthetic oil chemical engineering as we will go.

Synthetic base stocks have superior lubricating characteristics compared to petroleum-based oils. After a base stock is selected, manufacturers blend in their unique additive packages to give their oil its full range of performance characteristics. Although both synthetic and petroleum oils use similar additive packages, the additives work better in synthetic oil.

Not so new

The synthetic automotive oils now available first appeared in the United States in the mid-1970s, but the history of synthetics actually goes back a century earlier.

Professor Charles Friedel, a French chemist, and Professor James Mason Crafts, an American chemist, working together, were pioneers in hydrocarbon (petroleum-based) chemistry. The two are generally recognized for creating the first synthetic oil in 1877. However, more than 50 years passed before Standard Oil of Indiana developed a practical method of producing synthetic oil in commercial quantities. But the oil's very high cost, compared to the price for petroleum-based lubricants, which were more than adequate to meet the engine performance demands of the time providing recommended change intervals were concerned, doomed synthetics in the marketplace.

War-time necessity gave synthetics their first practical applications. In the mid- to late-1930s, Germany took the lead on synthetic research.

World War II was imminent, and having limited access to petroleum, German chemists developed several synthetic alternatives to conventional lubricating oils. The crankcases of the diesel engines that powered German tanks during the battles on the frigid Russian front were filled with synthetic oil.

Synthetic oils also helped pave the way for the development of jet aircraft during the last days of WWII and into the 1950s. Jets run much hotter than piston engines and have much

tighter bearing clearances. Petroleum-based oils simply could not withstand the temperatures and provide the lubrication that jet engines required, so synthetics became absolutely necessary.

In a large part, the development of synthetic automotive motor oil can be traced to the use of synthetics in jet engines. One pioneer in this effort was Air Force Lt. Col. Albert J. Amatuzio, a pilot stationed at an air base in northern Minnesota during the 1960s. Recognizing the outstanding performance of synthetics in jet engines, especially considering Minnesota's brutal winter temperatures, Amatuzio began experimenting with synthetics for automotive use. He later developed one of the first commercially-available synthetic automotive engine oils, AMZOIL (Amatuzio-oil) in the early 1970s.

In 1973, Mobil began marketing its synthetic oil in Europe. A year later, the company introduced Mobil 1 synthetic oil in the United States. Since the mid-1970s, the synthetic market has been joined by products from most of the major oil companies and numerous lubricating oil suppliers.

The demand for synthetics received a boost from an unexpected source—the environmental movement. In the late 1960s and early 1970s, the automotive industry began grappling with newly-introduced emissions regulations. A hotter-running engine helps reduce certain emissions, so the carmakers started designing engines that ran hotter. But the temperatures were so high, petroleum-based lubricants would fail unless the oil was changed frequently.

Because synthetics could withstand higher engine temperatures without a problem, synthetic manufacturers anticipated rapid sales growth. That didn't happen because changes in refining and additive packages enabled petroleum-based oils to perform adequately in the hotter running engines.

Teething problems

The early seal problems have been solved – the formulations for both synthetics and seal materials have been changed. Seals in any engine made after 1980 are compatible with both conventional and synthetic oils.

Before you retrofit one of your customer's cars to synthetic oil, make sure you've found and fixed any leaks that might be present. Otherwise, minor seepage may escalate to heavy bleeding. By the way, nothing beats crankcase dye and a UV light for zeroing in on a leak.

The existing-leak issue remains. If an engine leaks with conventional oil, it will really leak with a synthetic. If you have a customer who has been using petroleum based oil and wants to shift to a synthetic, you should check for leaks before accepting the job. If the engine is excessively dirty, sell the customer an engine cleaning, which will make leaks much easier to find. Any leaks must be repaired before switching to a synthetic. Otherwise, guess who's going to eat the cost for fixing a high oil consumption problem "caused by that synthetic oil you put in my car"!

In the 30+ years synthetics have been on the market in the United States, the formulations for both the base stock and the additive packages have been continually revised to meet new standards. Environmental regulations, which gave synthetics their first boost, continue to push better synthetic oil performance. *"Environmental standards have been the big driver in the reformulation of Mobil 1,"* says a company spokesman.

As emissions standards have gotten tighter, oxygen sensor and catalytic converter contamination control has become more critical. Engine

oils cannot release any substances that might contaminate oxygen sensors and catalytic converters. Meeting these requirements can be a challenge.

"We had to reduce Mobil 1's phosphorus content to protect the catalytic converter. But phosphorus was part of our anti-wear additive, so we had to develop a new additive formula for resist wear. And when you reduce oil consumption to keep the converter cleaner longer, that means oil stays in the crankcase longer. Which means you have to have a better anti-oxidant additive for longer oil life," the spokesman tells ST. *"Every time we develop a new formulation, we think we have the best oil we've ever produced. But then we have a new requirement to meet and we go back to the lab and produce an even better oil."*

Aftermarket Additives

Although the profit margin on aftermarket oil additives can be very attractive, the reality is that these products offer little, if any, value. In fact, some additive manufacturers have been forced to either change their claims, or even pull their products from the market, because they could not provide independent testing that supported their claimed benefits.

Mercedes-Benz, along with all of the other carmakers, has already done extensive testing on engine lubricants. And, working with the oil companies, the carmakers have developed recommended formulations to meet lubrication performance requirements without requiring any aftermarket product.

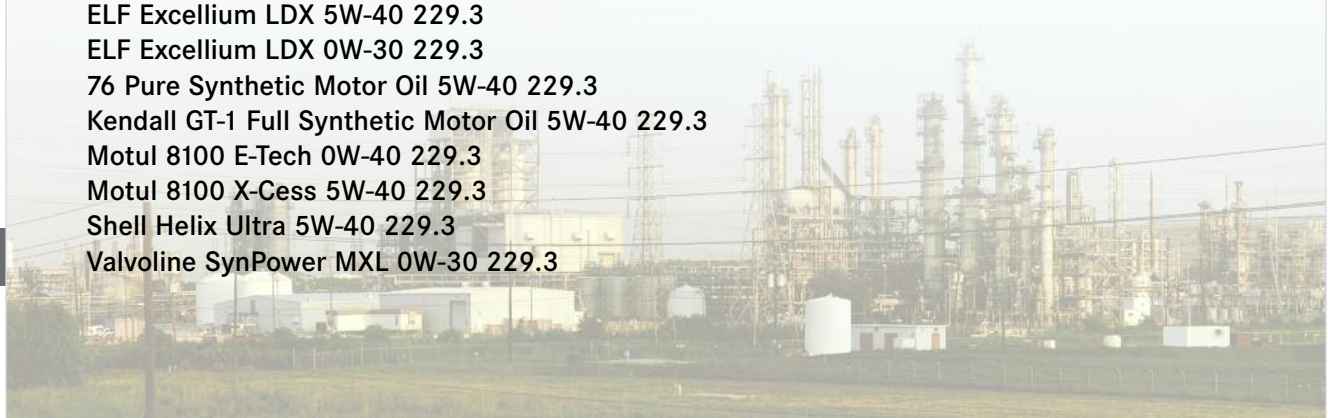
In fact, some aftermarket additives may lead to fouling of the catalytic converter and other emission control systems when used for a prolonged period of time. The newer generations of synthetic oil are formulated to contain less of the compounds that may foul emission control devices.

There's no need to have a degree in chemistry or chemical engineering to determine which synthetic is best for your customer's car because Mercedes-Benz has already done the analysis for you. Just select one of the oils on the Mercedes-Benz list of approved synthetics (see accompanying sidebar), change the oil and filter, and perform the other services based on FSS monitoring and your customer can count on enjoying his or her Mercedes for a long, long time.

Approved Oils

Each of these oils meets or exceeds the company's MB 229.3 or 229.5 Lubrication Certification Standard, as noted. Use 229.5 oils in 2005 and later model year vehicles:

Mobil 1 SuperSyn European Car Formula 0W-40 229.5
Castrol Syntec European Formula 0W-30 229.5
Castrol Syntec 5W-40 229.3
Pennzoil European Formula Ultra 5W-30 229.5
Pennzoil Synthetic European Formula 5W-40 229.3
Quaker State European Formula Ultra 5W-30 229.5
Quaker State Full Synthetic European Formula 5W-40 229.3
ELF Excellium 229.5 5W-30 229.5
ELF Excellium LDX 5W-40 229.3
ELF Excellium LDX 0W-30 229.3
76 Pure Synthetic Motor Oil 5W-40 229.3
Kendall GT-1 Full Synthetic Motor Oil 5W-40 229.3
Motul 8100 E-Tech 0W-40 229.3
Motul 8100 X-Cess 5W-40 229.3
Shell Helix Ultra 5W-40 229.3
Valvoline SynPower MXL 0W-30 229.3



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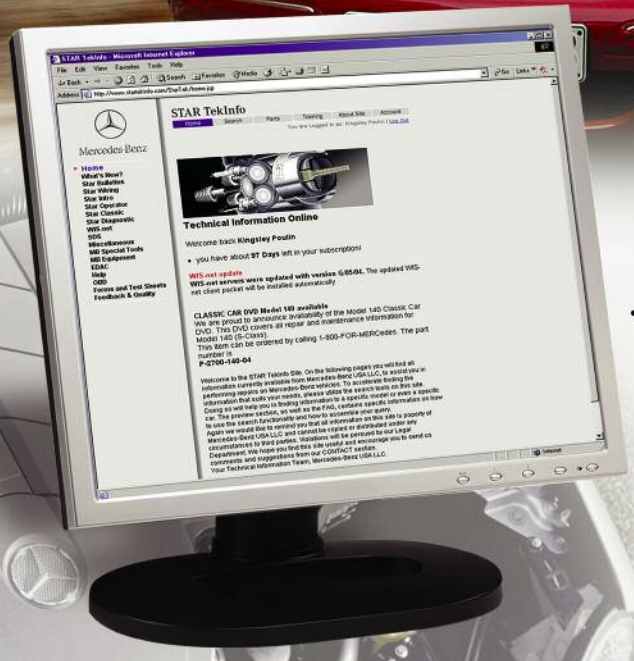

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Mercedes-Benz

ESP SPELLS SAFETY

Helping to keep drivers safe even when they make mistakes

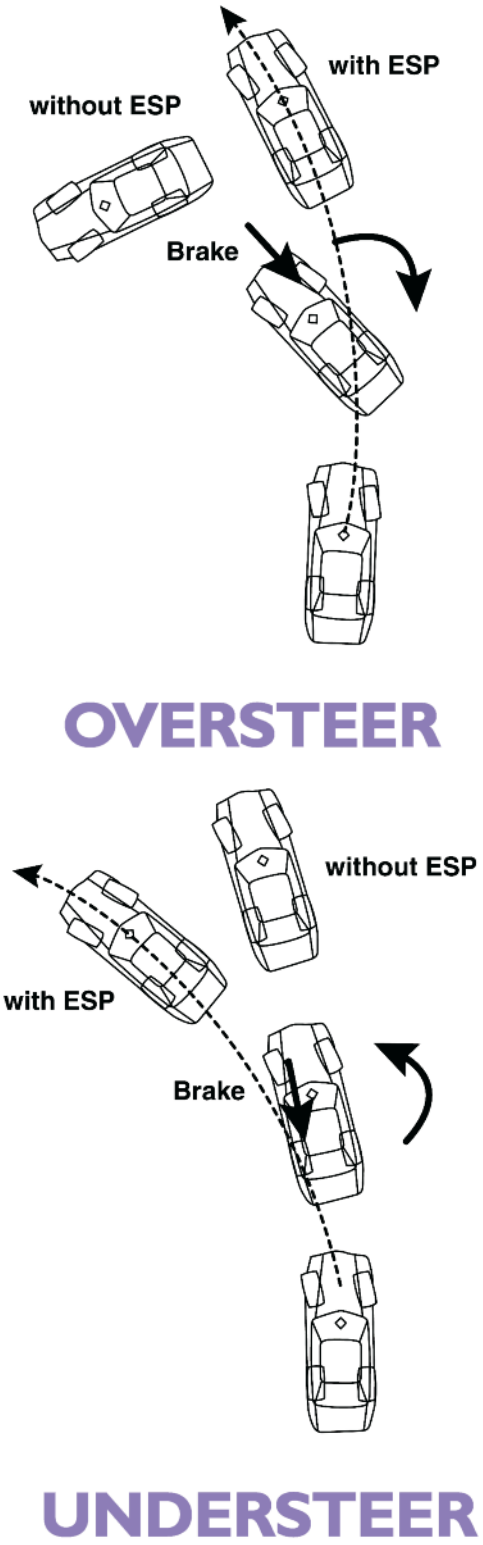
No other recent automotive innovation has had such an immediate impact on accident-avoidance safety as the electronic stability system, such the Mercedes-Benz ESP (Electronic Stability Program). Multiple traffic safety studies, done by private groups and government agencies in the United States and Europe, credit stability control with reducing single-car crashes by up to 35 percent. For SUVs, the results are even more dramatic. The National Highway Traffic Safety Administration (NHTSA) says ESP cuts "single-vehicle" SUV crashes by 67 percent. Logically enough, according to the reports the reduction in accidents is accompanied by a corresponding reduction in fatalities and injuries.

In a statement issued when NHTSA released its findings, the agency said, "Electronic stability control appears to be highly effective in reducing single-vehicle run-off-road crashes such as rollovers and collisions with fixed objects . . . This technology appears to provide safety benefits by reducing the number of crashes due to driver error and loss of control, because it has the potential to anticipate situations leading up to some crashes before they occur, and has the capability in some cases to automatically intervene to prevent them."
According to NHTSA, if all vehicles on the road in the United States had an ESP system, up to 800,000 of the approximately 2 million single-vehicle crashes that now occur every year might be prevented.

The development of ESP was a multi-year "tandem" project done by Mercedes and Robert Bosch GmbH. "Tandem" is the term Mercedes uses to describe a complex project development effort between Mercedes and one of its key suppliers. According to Mercedes, because of its partnership approach with Bosch, "The usual time to develop such a system (ESP) was reduced by one-third, and development costs for the new system were lower than for the basic ASR traction control system." Mercedes-Benz introduced ESP in the 1996 model year and it is now standard on all cars and SUVs.

Function

With the exception of drag racing and setting land speed records at the Bonneville Salt



When a vehicle "oversteers," it turns too much, with the front end turning more than the driver intended (fishtails). When a vehicle "understeers," it doesn't turn enough. Instead of making the turn, the vehicle tends to slide toward the outside edge of the curve (plows).

Flats, the ability to handle a car in the corners is critical to motorsports. Races are won and lost in the corners, and drivers are judged on how quickly and smoothly they can maneuver their car through a turn. When cornering, race drivers want to be on "the line" that allows them to make the turn smoothly and exit the turn, heading for the straight, at the highest possible speed.

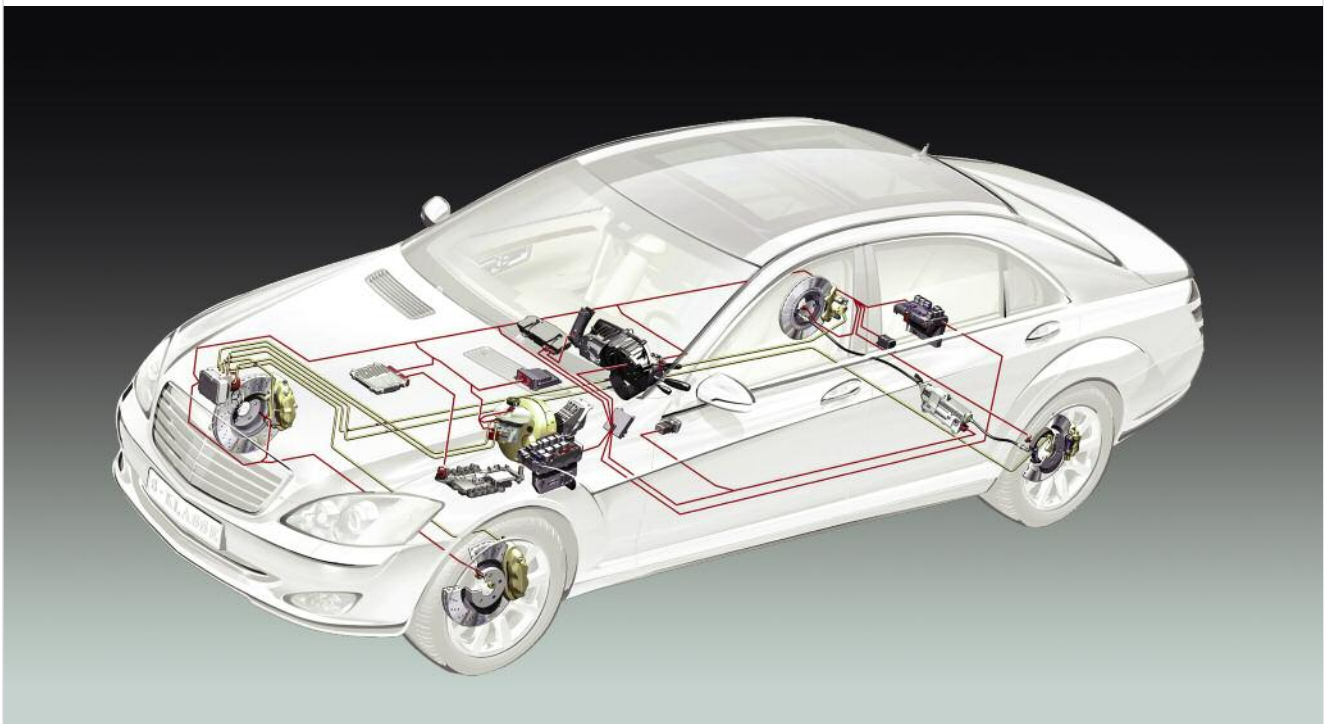
If a driver misjudges his speed going into a corner, and can correct it in time, the only penalty is losing too much speed or taking too long to make the turn. If the driver cannot correct the mistake, the car will either "understeer," going off the line and heading for the outside of the curve, or "oversteer," with the rear of the car swinging around quickly and possibly going into an uncontrolled spin. In NASCAR terms, a car that has a tendency to understeer is "tight" and "pushes." A car that wants to oversteer is "loose."

On the highway, the ability to safely control a car through a turn is no less important than on a race track. Most of the time on the road, speeds are slow enough, and road conditions are good enough, that safely controlling a car is not difficult. But whenever the combination of speed and road conditions creates a situation that approaches the limits of the vehicle's ability to stay on the road, losing control because of understeer or oversteer is a serious risk.

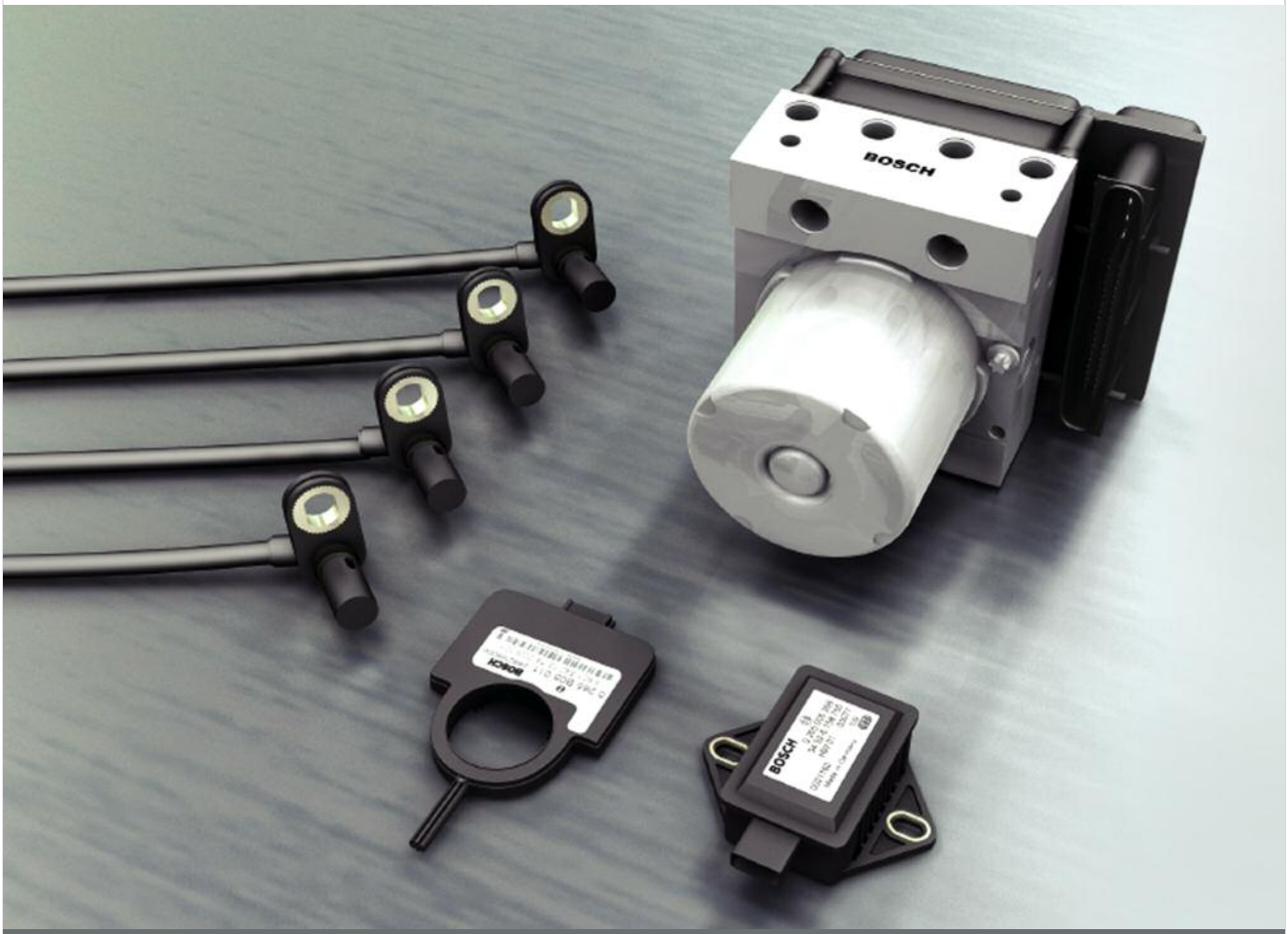
Unfortunately, most motorists don't know the signs or the "feel" of a vehicle approaching its handling limits. They don't realize something is about to go wrong, until it happens and they have lost control. Then the typical response is to slam on the brakes and hope for the best.

Safely driving a car at or near its limits is a skill gained only with training, practice, and maybe a few crumpled fenders. Until ESP, that is. In a Mercedes-Benz car or SUV with ESP, the system senses an impending loss of control, either understeer or oversteer. It then corrects the problem by selectively applying the brakes. ESP can even apply brake force to only one wheel, something not even the most skilled driver can do.

Under dry road conditions, ESP is probably not particularly valuable to the rare, highly-trained driver who is skilled and experienced at



This illustration shows the location of the ESP sensors and microcomputer in a new S-Class. The basic component placement is the same for all Mercedes-Benz cars and SUVs equipped with ESP.



ESP shares some components, like the wheel speed sensors, with the ABS and ASR systems. But the yaw rate sensor and steering wheel angle sensor are strictly for ESP.

driving a car near the limits of control. But ESP is very valuable in protecting the majority of drivers who find themselves in a situation where they are going too fast to make a turn. On wet or icy roads, even a skilled driver will benefit from having ESP because the system can regulate braking more effectively than even the best driver is able to do.

Extra Sensory Perception?

The development of ESP was the logical outgrowth of the marriage between chassis components and electronics that started when Mercedes introduced anti-lock braking (ABS) in 1978. ABS prevents individual wheels from locking under hard braking. After ABS, the next step was ASR (Acceleration Slip Regulation) traction control, which is the mirror of ABS. Instead of preventing wheels from locking up, which is what ABS does, traction control prevents excessive wheel spin when the tires on the drive wheels can't get traction or "bite" on the pavement during acceleration.

ESP essentially combines ABS with additional sensors to monitor the driver's steering wheel input and the directional movement of the car. ESP components include:

- **Wheel-Speed Sensors**

Signals from the wheel speed sensors, already used for ABS and ASR, are key inputs to the ESP system. ESP continually monitors the relative speed of each wheel. Variations in wheel speed between outside and inside wheels are also used as a double check against the lateral acceleration sensor's reading of the gravitational or sideways forces on the vehicle.

(Continued on page 20)

Genuine Mercedes-Benz Rema

Why Buy Genuine?

Replace — We replace more parts than aftermarket brands.

Engineered — Designed to meet original OEM drawings.

Manufactured — Made with same OE components as factory parts.

Assembled — Completely assembled from components and not just repaired.

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Quality, Reliability and Value

The quality, reliability and value of the Genuine Mercedes-Benz Remanufactured A/C Compressor wasn't meant to be taken lightly. It is not only an exact replacement for the original unit, it's also remanufactured and tested to meet the same strict specifications as the original, so it performs just as well. And like all remanufactured parts, it's covered by the Mercedes-Benz limited parts warranty.* In fact, the only detectable difference you'll find between a Genuine Mercedes-Benz Remanufactured A/C Compressor and a new one is the price. Which we're sure you'll find quite refreshing.

It's All In the Process

Remanufacturing Process (Genuine Mercedes-Benz)

1. Dismantle core and clean all components.
2. Replace key components 100% with new OE part.
3. Test all other critical components.
4. Replace components that do not meet specs.
5. Assemble, test and box.

Rebuilt Process (Typical Aftermarket)

1. Identify damaged part or parts.
2. Replace damaged part with non-OE part and clean.
3. Re-assemble, test and box.

*See your Mercedes-Benz dealer for details and a copy of the Mercedes-Benz Spare Parts Limited Warranty.

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(Continued from page 17)

- **Hydraulic Modulator**

ESP shares the same hydraulic modulator with ABS and ASR to regulate brake force. ESP, like ABS, can regulate braking at individual wheels to prevent loss of control. As Mercedes-Benz puts it, the system acts like it has four pedals, one for each wheel.

- **Steering Wheel Angle Sensor**

This sensor monitors the driver's steering wheel input to determine where the driver wants the car to go. The steering-wheel angle sensor has a working range of 720° with a tolerance of ± 5°.

- **Yaw Rate Sensor**

The yaw rate sensor measures the rotation of the vehicle around its vertical axis. Picture a bird's eye view of a car, looking straight down. The more the back end is shifted or rotated from a straight-ahead direction, the greater the yaw. If the centerline of the car is exactly on the direction the car is traveling, the yaw is zero. If the rear end has spun out, either to the left or right, so that the car is exactly sideways to the direction of travel, the yaw is 90 degrees. The rate of yaw change is measured continuously as the vehicle is traveling.

- **Micro-Computer**

The ESP input signals are processed by the onboard computer, typically at the rate of about 25 times per second. Basically, the computer looks at the steering angle input—which is where the driver wants the car to go—and compares it with the input from the yaw rate sensor, which indicates the direction the car is going, as well as other sensors.

Calculations and actuations

The ESP works in the background – drivers almost never know it's there. Even when the system corrects an out-of-control problem, the motorist is barely aware of what just happened.

Unlike ABS, which only works when braking, or ASR, which only comes into play during acceleration, ESP's benefits are always available. Whenever the vehicle is moving, whether accelerating, traveling at a steady speed, or braking, ESP is monitoring the various inputs and taking corrective action as necessary to prevent loss of control. The system is effective on all road conditions, including rough, uneven surfaces; loose gravel; and snowy, icy, or wet roads.

ESP uses the angle of the steering wheel and the individual speeds of the four tires to calculate the path being steered or the direction the driver wants the car to go. At the same time, ESP, based on the gravitational forces and amount of yaw, measures what the car is actually doing.

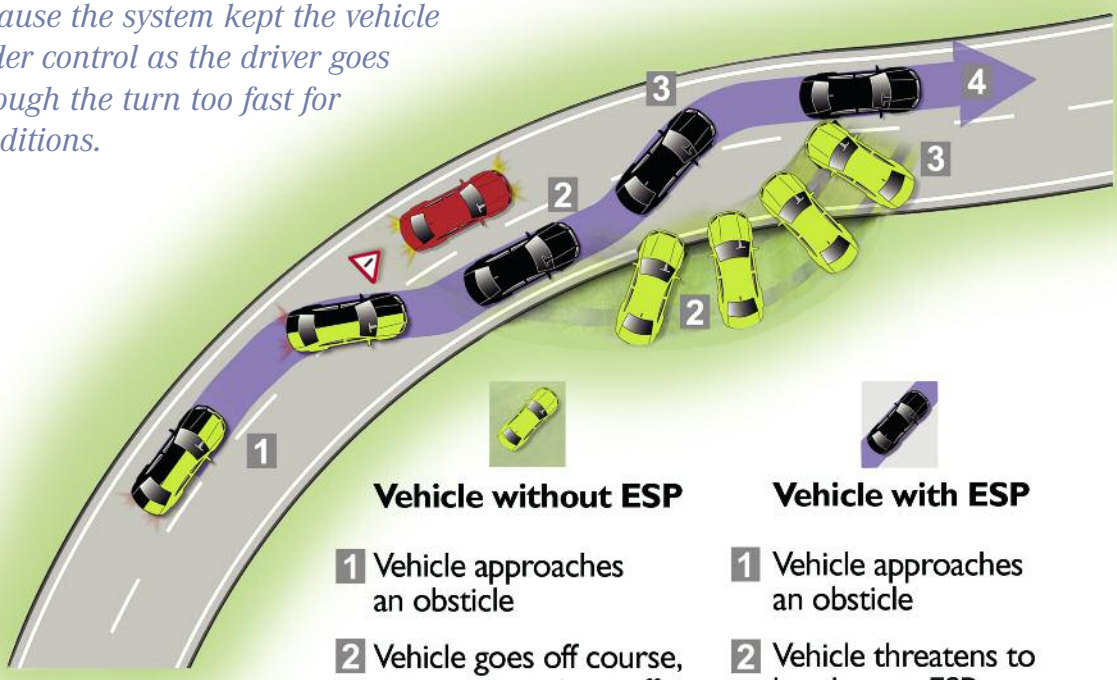
Minor differences between the steering wheel angle input and yaw rate input do not trigger ESP action. But when the difference becomes significant, ESP goes to work. When the system detects an understeer condition, with the car trying to push toward the outside and not follow the turn, ESP applies brake hydraulic pressure to the inside rear wheel. If oversteer is detected, with the back end starting to swing around and put the vehicle into a spin, ESP increases brake pressure to the outside front wheel. For example, if the back end starts sliding to the right, ESP applies the right front brake to counter the oversteer and stabilize the vehicle (see page 15).

Just as ABS can "pump the brakes" for maximum braking faster than any human can, ESP braking control effectively provides faster counter steering to correct a skid than most drivers can.

ESP can't raise "cornering speed" or the maximum speed that a car can travel going through a turn. Maximum cornering speed for any given corner, at any given time, is a complex function of the vehicle's weight, engine power, suspension, brakes, tires, total chassis dynamics, and road conditions.

And, as the old saying goes, "Nothing is foolproof to a sufficiently talented fool." If, for example, a driver tries to take a hard right turn at 90 miles an hour on a rain-slicked or icy road, ESP will do what it can to keep the car going where the driver wants to go, but the odds are very good that the driver will soon be testing other Mercedes-Benz safety features, including seat belts, airbags, and crumple zones.

With ESP, a potential crash is avoided because the system kept the vehicle under control as the driver goes through the turn too fast for conditions.



Vehicle without ESP

1 Vehicle approaches an obsticle

2 Vehicle goes off course, enters oncoming traffic lane and driver loses control

3 Countersteering causes the vehicle to skid

Vehicle with ESP

1 Vehicle approaches an obsticle

2 Vehicle threatens to break away. ESP intervenes and restores full steerability

3 Countersteer results in threat of renewed breakaway. ESP intervenes again.

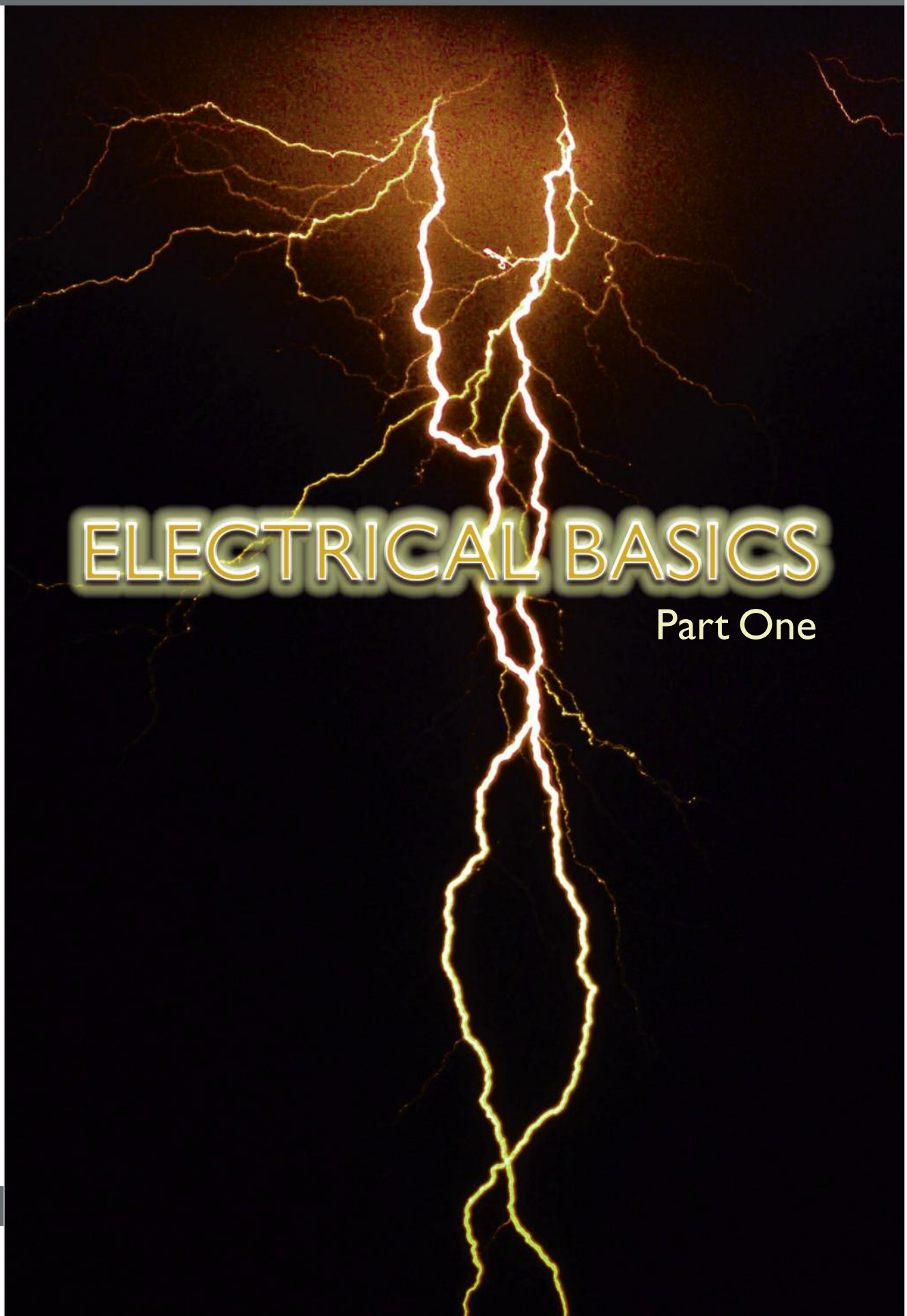
4 Vehicle is stabilized

Zero complaints

No routine maintenance is required for ESP, and drivers don't have to make any changes in their normal driving habits to benefit from the system. You should, however, advise customers to use only tires approved by Mercedes-Benz for their cars. And, as with ABS and ASR, ESP requires that all four tires be the original size and type. Differences in tire adhesion caused by using unmatched types or brands of tires reduce the effectiveness of ABS, ASR, and ESP.

Even vehicles with AWD and 4WD benefit from having ESP. AWD and 4WD give improved traction, especially when road conditions are poor, but they do not automatically correct loss of control situations when oversteer or understeer occurs. Only ESP can do that.

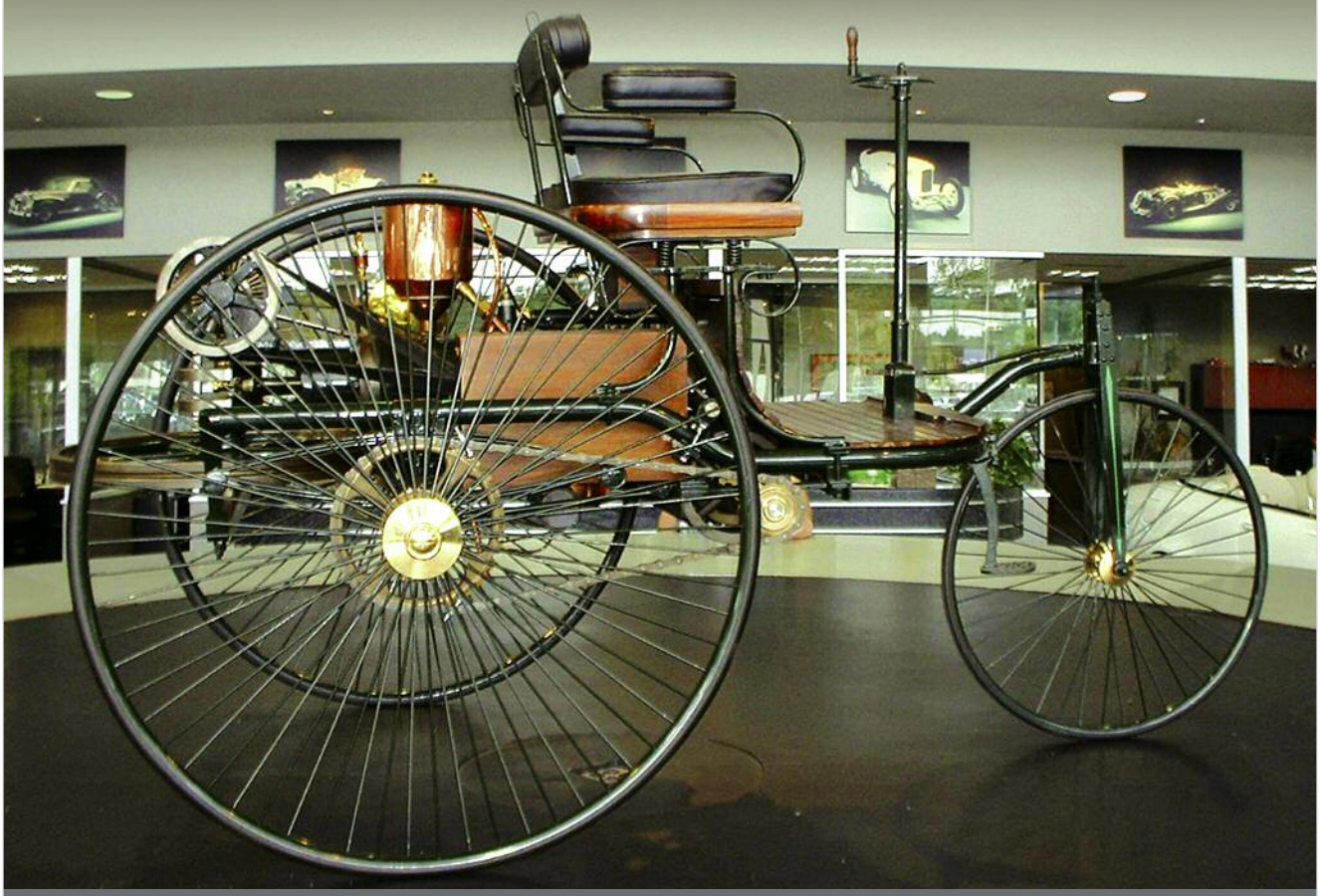
For all its complexity, ESP is very reliable. Because the system works in the background, and drivers often are not even aware of its presence, owner complaints about ESP performance are rare. Typically, the problems with ESP are sensor malfunctions that trigger a MIL (Malfunction Indicator Lamp). As with any code indication, follow the Mercedes-Benz diagnostic procedure for the specific vehicle year and model. Also, when the battery is disconnected, you might find that the ESP warning lamp is on, but the one for ABS is not. This is because the steering wheel angle sensor isn't initialized. Simply turn the wheel lock to lock a few times with the key on. The only general troubleshooting advice we can offer is to check the wheel speed sensors for physical damage.



ELECTRICAL BASICS

Part One

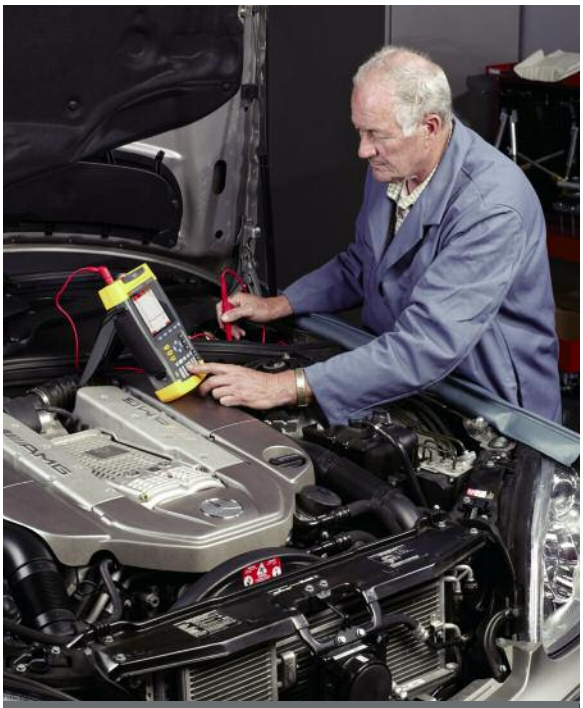
Don’t be dazed and confused by electrical troubleshooting. This first installment of our two-part story gives you the fascinating theoretical background.



Just think about this for a minute: The 1886 Benz Patent Motor Wagen, which is generally considered to be the first viable car, had virtually no electrical system. We've come far.

Except for the occasional spark, or the glow of a filament, electricity is invisible, and it's hard to comprehend something you can't see. So, it's understandable that many technicians, novices and veterans alike, would have dark corners in their minds on the subject. When you follow a Mercedes-Benz electrical diagnostic procedure, are you just performing the steps, or do you really understand what the readings mean? The results you get during your testing will make much more sense when you can interpret the numbers, not just read them.

This article is not intended to make you an electrical engineer, but just to give you a start. We'll cover only basic 12 volt, direct-current automotive circuits this time, but future articles will go into greater depth on testing and troubleshooting. By the way, we're talking about electrical, not electronics – there's a difference (see sidebar on page 27).



A solid knowledge of basic electrical concepts will enhance your skills as a Mercedes-Benz technician when you perform any diagnostic test procedure (courtesy Fluke).

Most electrical testing is done in the shop, but occasionally you have to test in "on the road" conditions. The only safe way to troubleshoot on the road is to have one person driving and one person using the meter (courtesy Fluke).

Pumping electrons

The easiest way to understand electricity is to think of water flowing through a pipe. To get the water to move, you must apply pressure. The amount of pressure and the diameter of the pipe determine the volume of water that moves during a given time. If you apply the same amount of pressure to a small pipe as to a large pipe, more water will move through the large pipe because it has less resistance.

Now, a little nuclear physics, greatly simplified. Everything is made up of atoms. Each atom has three major components—protons, neutrons, and electrons. The protons and neutrons are clumped tightly together to form the atom's center or core. The electrons orbit the core, sort of like planets orbiting the sun. Protons have a positive charge, neutrons have no charge, and electrons have a negative charge. Individual atoms have no electrical charge because each atom has an equal number of the positively charged protons and the negatively charged electrons and the charges cancel each other out.

The nucleus of the atom, containing the protons and neutrons, is incredibly stable. Which is a good thing, because the term used to describe an atomic core coming apart is "nuclear explosion," which is something that would ruin your day.

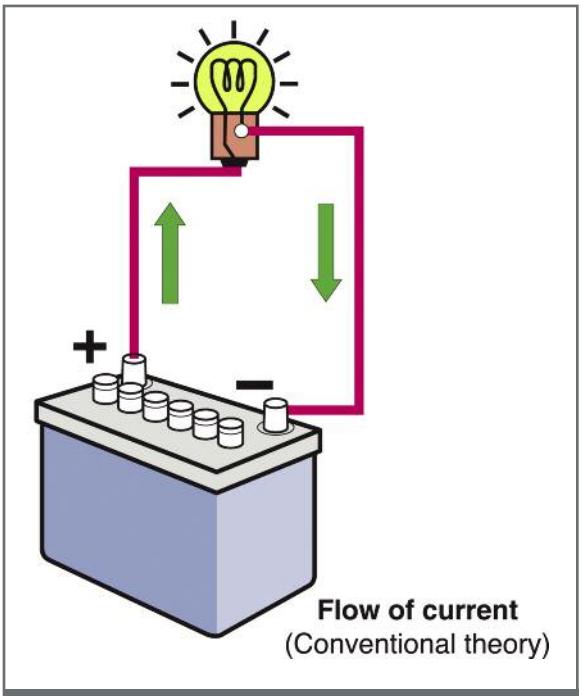
Normally, electrons stay in their orbits. But electrons are not tightly bound to the core of the atom. Under certain conditions, electrons will leave the orbits around one atom and jump into orbits around another atom, then another atom, and another atom, like a game of leap frog involving nearly countless electrons moving at almost the speed of light (186,200 miles per second). Electrons will jump from orbit to orbit because of a chemical reaction (which is what happens inside a battery), magnetic induction, or friction. The movement of the electrons is what causes an electric current – actually, it is electric current.

Two things to remember:

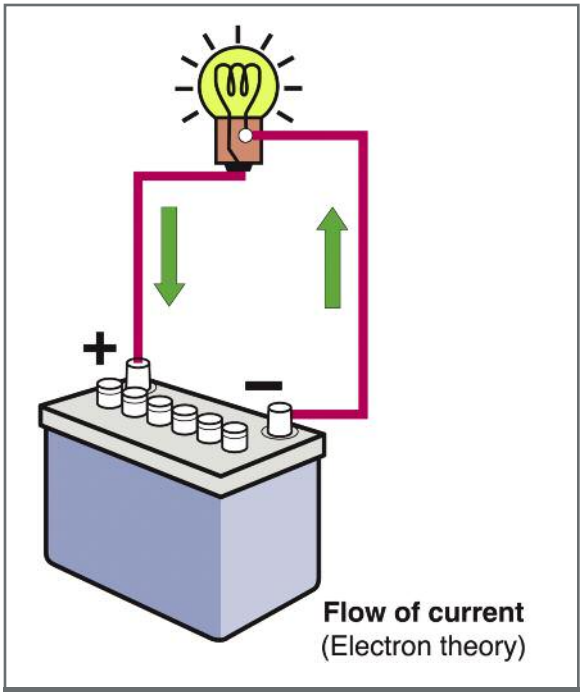
• It takes some external force—as we said, chemical reaction, magnetic induction, or friction—to cause electrons to flow. In other words, the other energy source is converted to electrical energy.

• No electrons are created or destroyed when there is an electric current. The electrons only move from one point to another within the circuit. As one of our editors once said, "Only recycled electrons have been used in the creation of this magazine."

To continue our hydraulic illustration, think about a closed water system consisting of a pump, reservoir, and piping. When some external force causes the pump to move, the water flows out of the reservoir, through the pipes, and back to the reservoir. Because the system is closed, no water is added and no water is lost, it simply moves from one point to another throughout the system.



Almost every Direct Current diagram shows current flow starting at the positive terminal of the battery, passing through the circuit, and returning to the negative terminal or a ground. Actually, the current flows in the opposite direction. But the distinction is not important for automotive service work, which is why most diagrams and schematics use what's known as "conventional theory."



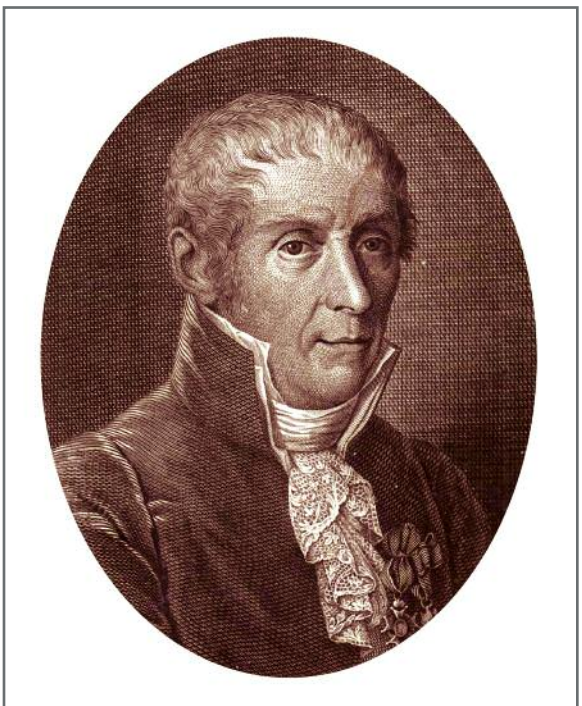
The scientifically-accurate electron theory describes Direct Current flow from the negative terminal to the positive terminal. The correct direction of current flow was not understood until long after the "conventional theory" was established, which is why most people continue to use the "positive to negative" concept of conventional theory. If you see a diagram showing negative to positive flow, it isn't wrong, the drawing is simply showing electron theory flow.

If electrons flow in only one direction, it's called "Direct Current" or "DC." DC is fine for relatively small electron flow over short distances, which is why it is the current found in automotive use.

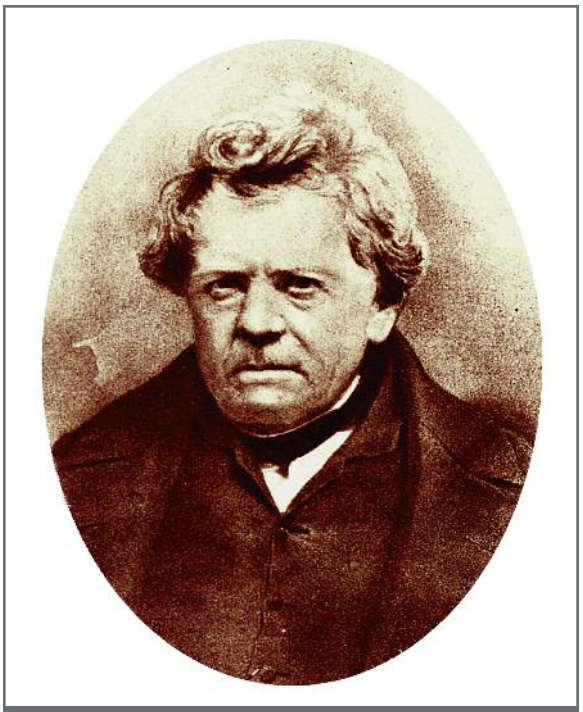
For large current flow over long distances, DC doesn't work very well. That's why the electrical power to your home, your shop, or any other commercial application is "Alternating

Current" or "AC." In an AC circuit, current flow changes direction rapidly, going back and forth within the circuit typically at 60 cycles, or 60 Hz. Because AC is not commonly used in automotive applications (except, of course, for the charging system – the alternator produces AC, but that current flow is immediately rectified to DC by diodes for use throughout the car), we're not going to cover it in this article.

It's interesting to note that virtually all DC wiring diagrams, including automotive schematics, are technically wrong. The diagrams show electrons leaving from the positive terminal, passing through the circuit, and returning to the negative terminal. In fact, electrons actually go the other way, from negative terminal to positive. When the earliest research into electricity was being done in the late 1700s and early 1800s, none other than our own Ben Franklin—patriot, statesman, scientist, inventor, and kite flyer—made the decision to label one terminal "positive" and the other "negative" and then declare that was the direction of current flow. Unfortunately, Ben guessed wrong, but the error was not discovered until long after the early scientific work was completed and the positive to negative idea was firmly in place.



Count Alessandro Volta, 1745 – 1827



Georg Simon Ohm, 1787 – 1854

For most DC work, however, it doesn't really matter how electron flow is described. If you ever hear people referring to "electron theory" when talking about DC circuits, they mean electrons flowing from negative to positive, as they actually do. But most applications use what is called "conventional theory" to describe the positive to negative flow that most people are familiar with.

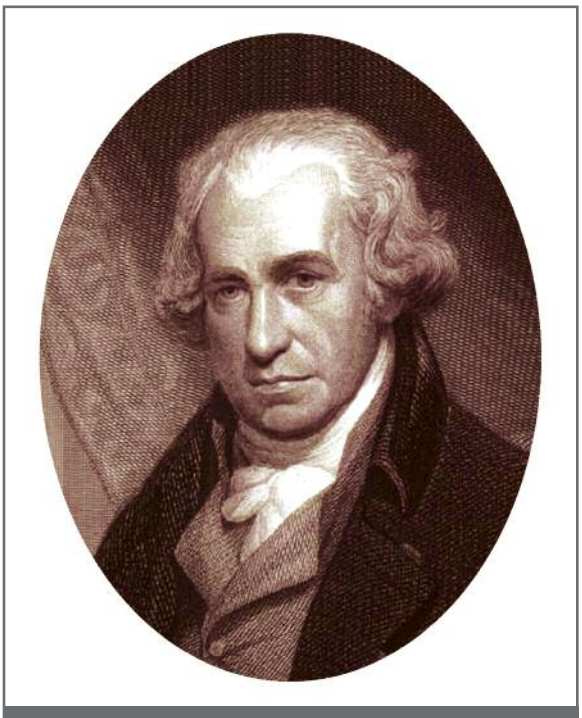
Players & Relationships

Electromotive force is what pushes current around a circuit. You can call it voltage potential, or the difference in the "pressure" on the electrons between the two ends of the circuit. One volt (named for the Italian scientist and Count Alessandro Volta, 1745-1827) is the force needed to push one ampere through one ohm. Or, one volt equals the difference in electrical potential between two points on a wire carrying a constant one ampere current when the power dissipated between the points is one watt.

An ampere (which appellation commemorates the French mathematician and physicist

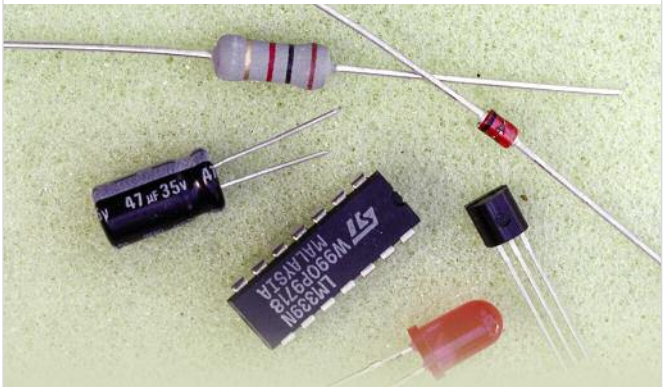
André Marie Ampere, 1775-1836), commonly referred to as an "amp," is one coulomb per second. What's a coulomb? It's a charge of about six quintillion electrons (that is, a six followed by 18 zeros). To put it another way, it's the quantity of electricity that is moving, somewhat like the number of liters or gallons a water hose can supply per second.

One ohm (from the German physicist Georg Simon Ohm, 1787-1854) is the resistance to electron flow that's present if moving one ampere through the resistor produces a one volt drop. In other words, one ampere requires one volt to be coerced through one ohm. To continue our hydraulic illustration, it can be likened to a restriction in a water hose.



James Watt, 1736 – 1819

Watts (after Scottish engineer James Watt, 1736-1819 did you notice that all these guys lived at about the same time?) are similar to horsepower. In fact, one horsepower translates into 746 watts. One watt is a unit of power equal to one joule per second, a joule being a unit of energy equal to the work done when one ampere is passed through one ohm for one second. You can get watts by multiplying volts times amps. So, a five ampere bulb on twelve volts is burning 60 watts.



DISTINCTION

We'd better make the distinction between the terms "electrical" and "electronic." The former refers to relatively simple devices that operate on or generate electricity, and the circuits necessary to feed and control them. "Electronic," on the other hand, implies the use of semiconductors such as transistors and diodes, and integrated circuits.

Unfortunately, that still doesn't make it perfectly clear, but you can tell the difference from experience. A starter motor is obviously electrical, while a radio or an electronic control module qualifies as electronic even though it's powered by electricity. Think of what an electrician has to know compared to the skills of an electronics technician.

What we're interested in here are the characteristics and behavior of electricity, to the exclusion of electronics.

While the plumbing analogy we used above is hardly scientifically exact, it does seem to aid understanding. Voltage is likened to water pressure, amperage to the volume flowing, and resistance to a restriction in the hose. The amount of work this flow can do (spinning a water wheel, for example) is measured in watts, and the "pump" may be either a battery or a generator/alternator.

In a future issue of StarTuned, we'll give you the most important practical points of this topic, which amount to applied science at its most interesting.

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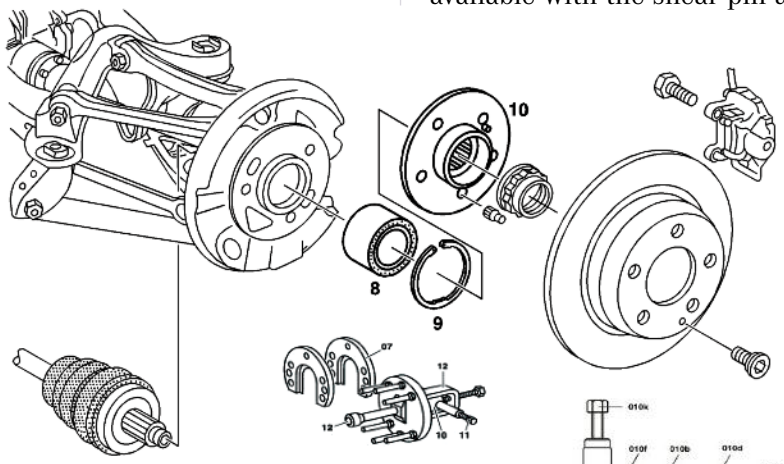
FACTORY SERVICE BULLETINS

These suggestions and solutions for technical problems come from service bulletins and other technical information published by Mercedes-Benz, selected and rewritten for independent repair shops.

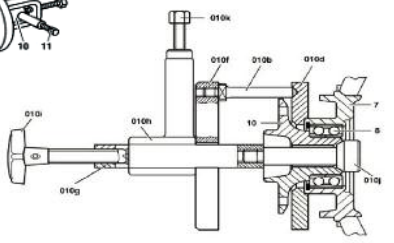
Removal of Rear Axle Halfshaft Flange with Double-Row Tapered Roller Bearings and Modification of Special Tool – Models 300TE, 300TE 4 Matic, 300TDT and E320 Wagon



These bearings can only be pressed out of the rear halfshaft flange with the wheel carrier removed from the vehicle first, and then by the use of a stationary hydraulic press to remove the double row tapered roller bearing itself.

These double row tapered roller bearings require extractor force three times that of the force required to pull the double row tapered ball bearings used on other models. The puller special tool number 202 589 04 43 00 is not designed to handle such forces.

The special tool puller should be modified with a shear pin, which is installed at the pressure screw of the hydraulic press. The pin will shear at a force of 40Nm, thus preventing any further pressure build-up at the hydraulic press, making the application (except on Model 124.090/092/193/290) of this tool safer on all vehicles. The modified pressure screw is available with the shear pin as



a spare part under the following special tool part number: 202 589 04 43 11.

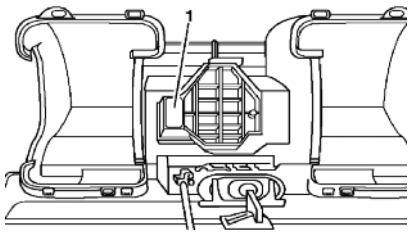
Note: Prior to removing the double row tapered ball bearing from the installed wheel carrier, review the following document in WIS: AR35.20-P-0130B.

Synthetic Oil Recommended with FSS All models equipped with the Flexible Service System

In case you haven't heard, Mercedes-Benz USA has changed the engine lubricant recommendation for all FSS-equipped vehicles (1998 and up): Use only MB-approved synthetic motor oil. Approved synthetic engine oils are listed in the MBUSA oil specification sheet 229.3 or 229.5 which also meet API SL/SM classifications. Oil specification sheets 229.3 and 229.5 for worldwide use can be found on the Workshop Information System (WIS).

MBUSA requests that all service facilities institute this transition from standard mineral oil to approved synthetic oil equipped with FSS technology.

Replacement of Model 129 Automatic Climate Control Blower Motor, 1996 and Up Production



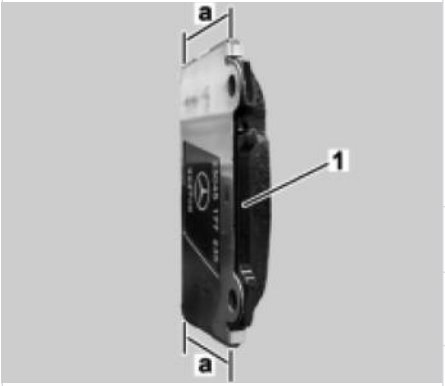
Effective with March, 1996 production, the overall dimensions of the blower motor have been changed. The overall length of the new blower has been shortened, so if the newer blower motor is installed it will shift due to not being seated. That is, unless an adapter around in the blower housing is used.

The adapter piece is supplied with the new blower motor, and must be inserted as shown for the new blower motor to properly seat in the blower housing.

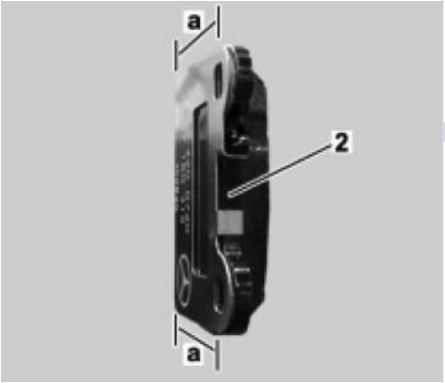
Note: *The blower motor used prior to 3/96 production is approximately 12.5 mm longer than the newer blower motor. The longer unit can be used in vehicles made after that date if the end stop is removed using a suitable tool.*

Front Brake Squeal Models ML430, ML500 and ML55 AMG

Although squealing brakes are not the problem they once were, the condition still shows up from time to time. It may be aggravated by cool, damp weather in combination with light braking effort. Besides switching to improved friction material, it's been found that the judicious application of brake paste to the ends of the pad backing plates as shown can reduce the noise. If you receive customer reports in the above model vehicles of brake squeal emanating from the front of the vehicle, please order the improved brake pads available from your local M-B dealer's parts department, and perform the following procedure:

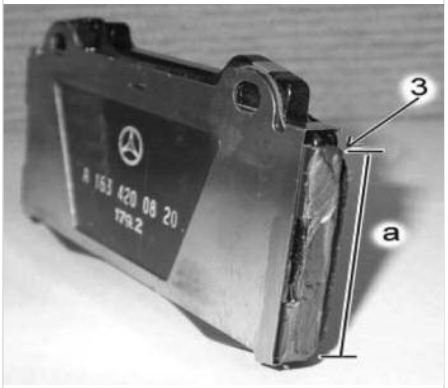


1. Remove the existing brake pads. Reference WIS document AR42.10-P-0161GI.



2. Apply brake pad paste to the ends of the replacement brake pads' backing plates as shown. Reference WIS document AR42.10-P-0161-01GH

Note: *Do not allow any paste to contact brake pad friction surface or apply paste to any other areas besides those specified. Immediately remove any excess paste that contacts pad front or back surfaces.*



3. Install the improved brake pads. Reference WIS document AR42.10-P-0161GI.

Parts Information

Qty.	Part Name	Part Number
1	Brake Pad Paste	A001 989 87 51
1	Brake Pad, Front	A163 420 10 20

Automatic Switching Off and On Of Electrical Consumers

All Model 211, E Class Vehicles

If you encounter the message, “Malfunction: Electrical Loads Switched Off” in white in the instrument cluster multifunction display on a Model 211 vehicle, this may be normal. Messages that appear in white inform the driver that loads not influencing driving safety have been switched off until the electrical system voltage has stabilized.

If battery voltage is too low, the heated seats and/or rear window defroster may switch off automatically. This is normal operation of those features and is indicated by flashing of the indicator lamps in the corresponding switches.

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Mercedes-Benz of Chandler
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Phoenix Motor
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Phoenix
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Fayetteville
Jones Motorcars
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Riverside Motors
501-666-9457

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Anaheim
Caliber Motors
714-777-1900

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Rusnak/Arcadia
626-447-1117

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661-836-3737

Belmont
Autobahn Motors
650-637-2333

Beverly Hills
Mercedes-Benz of Beverly Hills
310-659-2980

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213-748-8951

Manhattan Beach
Carwell
310-303-3500

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Modesto European
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Montclair
Penske Motorcars
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Smythe European
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Kimball Motor
805-543-5752

San Rafael
R.A.B. Motors
415-454-0582

Santa Barbara
Santa Barbara Auto Group
805-682-2000

Santa Clarita
Mercedes-Benz of Valencia
661-753-5555

Santa Monica
W.I. Simonson
310-526-4700

Santa Rosa
Smothers European
707-542-4810

Signal Hill
Mercedes-Benz of Long Beach
562-988-8300

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Berberian European Motors
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805-371-5400

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Keyes European
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Walnut Creek
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Penske Motorcars
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Colorado Springs
Mercedes-Benz of Colorado Springs
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Denver
Murray Motor Imports
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Littleton
Mercedes-Benz of Littleton
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Westminster
Glauser
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Mercedes-Benz of Danbury
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Fairfield
Mercedes-Benz of Fairfield
203-368-6725

Greenwich
Mercedes-Benz of Greenwich
203-869-2850

Hartford
New Country Motor Cars
860-278-2000

New London
Carriage House of New London
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North Haven
Mercedes-Benz of North Haven
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