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Information for the Mercedes-Benz Service Professional

November 2001 U.S. $6.00 DM 12.50

Mercedes-Benz Fuel Systems

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Volume 1 Number 2

Mercedes-Benz

To Our Readers

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

The worldwide carmaker 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 internal information sources combine to make this possible.

Feature articles, derived from official company information sources, focus on being useful and interesting. Our digest of service bulletins will help you solve unanticipated problems quickly and expertly. Our list of Mercedes-Benz dealers can help you find original, Mercedes-Benz factory parts.

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

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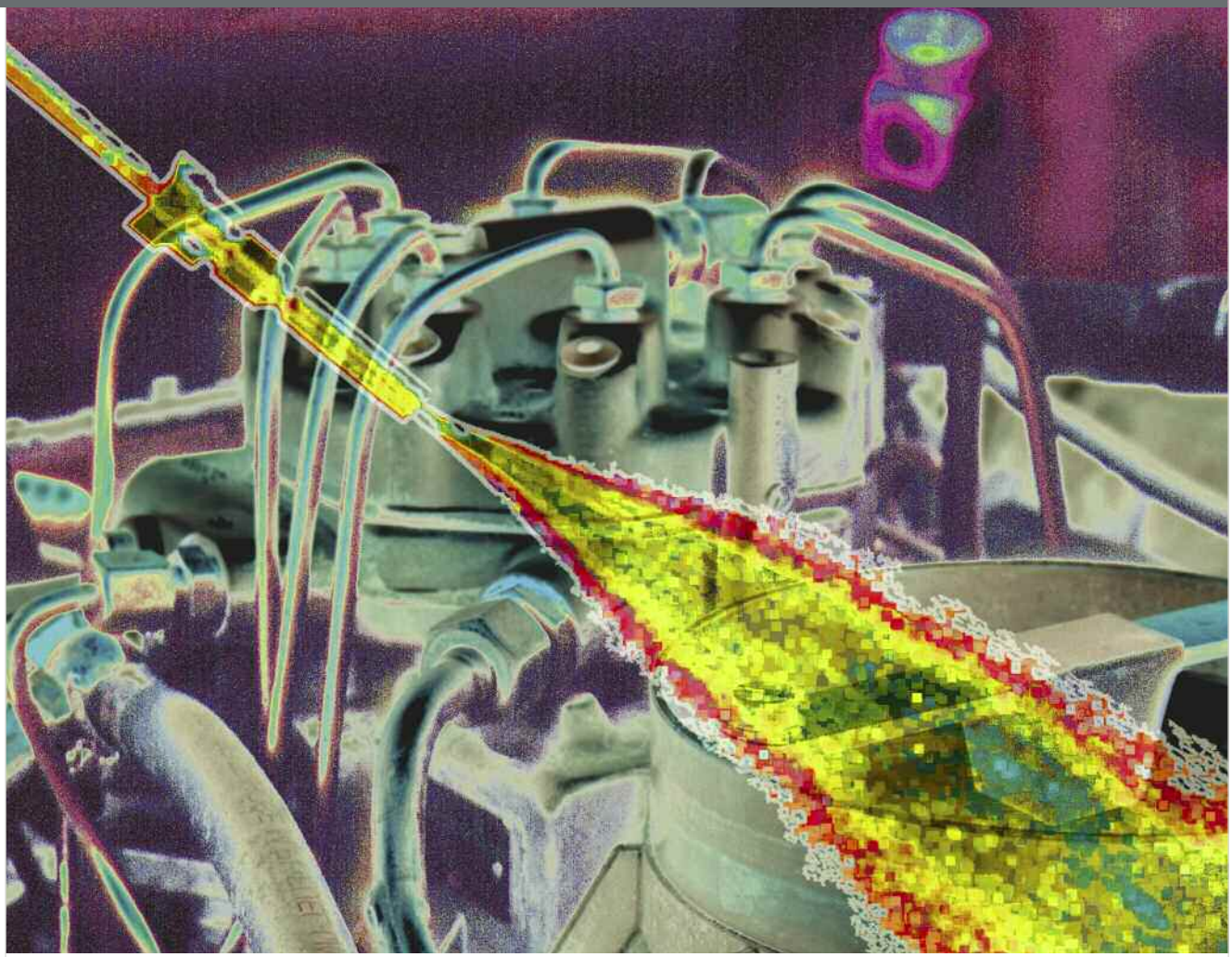
FEATURE ARTICLES

DEPARTMENTS



Fuel Injection Systems

How two M-B systems work in overall view

K-Jetronic Fuel Injection

Mercedes-Benz cars have a long history with various gasoline injection systems, including exotic versions as the Diesel-like direct injection used in the Gullwing SL of the early 1950's, spraying fuel right into the combustion chambers themselves. The M-B fuel injection system you're most likely to find in your workbay today, however, is one generation or another of the Bosch K-Jet series, beginning on some cars in the 1970's and continuing well into the 1990's. Shortly after emissions regulations began to require engine management systems that adjust air/fuel mixtures in response to a feedback signal from the exhaust system's oxygen sensor, the fuel injection system underwent a major evolution into the KE-Jet. K stands for the German word for continuous; E stands for the German word for electronic. We won't cover every detail of every variation of the K- and KE-Jet systems. The purpose here is to explain how the systems work in overall view. If you understand the overall system, you can diagnose and repair it if it fails.

Injector and bracket

The hallmark of the K-Jet systems, alone among fuel injection systems in widespread distribution, is this: As long as the engine runs, they spray fuel through their nozzles continuously. The injectors are entirely mechanical, opening at about 3.8 bar fuel pressure (gradually declining to 3.0 bar with use) and delivering whatever volume the system sends them, mechanically corresponding to the volume of intake air. There are no electrical parts or connections to these injectors; nothing turns them on or off; nothing pulses or cycles them in any way except the hydraulic force of the gasoline. High speed photography sometimes shows the nozzles 'chattering' at a frequency of about 1500 Hz, but that is entirely a consequence of the resonances of the needle, of the spring and of the viscosity and delivery speed of the fuel. Certain K-Jet injectors were microscopically formed so the needle 'walks' around the opening, further atomizing and vaporizing the fuel. To insulate the injectors from the engine's heat and vibration, they don't thread into the manifold but are just pressed in by hand, held by nonconductive rubber collars. The hex head only serves to steady the injector while you connect or disconnect the fuel line. Many injectors include an air shroud around the tip. Particularly at idle speeds, this air shroud insulates the fuel spray cone from the sides of the manifold where it might condense. The focused, high-speed airstream also helps vaporize the fuel even when the engine is turning slowly with no load.

But let's start where the fuel starts, at the fuel pump. For the earliest and simplest form of the K-Jet, this was the only electrical component, toggled on and off by the fuel pump relay on the firewall. There were no sensors, no computer, no actuators. Some of the technical literature at the time referred to the "airflow sensor," but as we'll see, the word sensor meant something entirely different from the way we ordinarily use it now. In principle, the fuel pump could have been mechanical, driven by a crankshaft pulley. But you want the pump away from the heat and near or inside the fuel tank to minimize vapor lock, while the engine and accessory drive is at the other end of the car.

Pump and filter

The basic K-Jet fuel pump has become the de facto automotive standard for all fuel injection systems. It's a small but powerful electric motor with a positive displacement hydraulic pump on one end of the shaft. Fuel fills and runs through the pump as it runs, cooling the armature windings. While the carbon brushes and copper commutator are surrounded with gasoline (recall that fuel bathes everything inside the motor), there is no room for air or oxygen, and thus nothing can catch fire. Sparking from an electric motor's carbon brushes could ignite fuel vapor in air, but sparking submerged in liquid gasoline can't.

Early versions had two speeds: on or off. All the fuel not injected into the intake runners recycled back to the tank, keeping the underhood fuel plumbing relatively cool. Some later versions included such complications as an additional, lower-current pump delivery rate for quiet low-speed driving, vehicle-speed limits by electronic control of the ground circuit, multiple pumps in series (one for pressure, the other for volume) and so on.

The first pumps worked by 'roller cells,' cylindrical bearing rollers held captive in channels around the outside of a drivewheel slightly eccentric with respect to the housing. As the rollers moved toward and away from the center as the drivewheel rotated, they drew the fuel from the tank and drove it toward the engine by displacement. 'Gerotor' pumps, internal/external gearsets that work like engine or transmission oil pumps, replaced them. Additional designs include cycling-vane and peripheral-pump designs and, on current M-B's, counterrotating helical spindles, forcing the fuel through with a geometry just like a scroll-supercharger's. In each case, the object is to move the fuel and build the pressure quickly and reliably. Changes in pump design have frequently been to make the pumps quieter. Because the fuel cools them so effectively, fuel pump electric motors can be surprisingly small for their power. You'll find most K-Jet pumps draw between 6 and 10 amps. A lower current should flag resistance in the circuit; a higher current means an internal short or a fluid block slowing the pump and making it work harder. A representative good pump for a six-cylinder engine delivers a liter in 40 seconds. Larger displacement engines get more fuel.

The pump for any given model can deliver more fuel than the engine could burn under the most adverse fuel-demand conditions: wide-open throttle at 40-below. This excess pump capacity guarantees full engine function and full fuel pressure even under extreme conditions. About the only factors

that can prevent a mechanically and electrically functional K-Jet pump from delivering enough fuel to the engine are a completely plugged fuel filter (very rare) or a crimped or blocked fuel line. These problems ordinarily cause a noisy pump since it has to work harder while they're present, and you'll hear the pressure pulses. If rust formed in the system after the fuel filter (because of moisture in the gas, perhaps), there can also be clogs at the small filters internal to the fuel distributor and to the injectors themselves.

In the fuel outlet of each pump there is a fluid check valve. Its function is to retain fuel in the injection lines to prevent vapor lock and to keep the plumbing full of pressurized liquid fuel for the next engine-start. The check valve merely seals the fuel in the system; the pressure derives from the pressure accumulator (see below). Long cranking times are the first symptom of a failure in the check valve or the pressure accumulator. For diagnostic purposes, a 'long cranking time' is more than four seconds before the engine fires.

Commutator and brushes

The fuel goes directly from the pump to the fuel filter. While this is the standard layout now, it is worth recalling that when carburetors walked the earth, fuel filters were often between the tank and the pump. Such an arrangement would often mean vapor lock with modern fuels in a fuel-injected vehicle (it often meant vapor lock with older fuels in carbureted vehicles, too!). Putting the fuel pump ahead of the filter, however, means the cleanliness of the fuel from the filling station is more important than ever. Any particles of grit or rust go through the fuel pump largely unfiltered, except for the coarse-mesh screen just ahead of the pump inlet. That screen serves mostly to block particles large enough to jam the pump.

Pump and screen

Accordian paper

Once it was standard practice to replace a fuel filter with every 'tune-up.' But there haven't been 'tune-ups' since the demise of ignition contact points, back in the 1970's. Modern fuel filters contain a large area of super-fine-mesh, accordion-fold filter paper capable of removing particles down to single-digit-micron sizes and of absorbing or neutralizing most gums and tars.

A filter actually cleans more effectively after it has been in use for some time and has collected a patina of dirt on the active filter surface. Unless there is clear, demonstrated need to replace a fuel filter – that is, a failure of a good fuel pump to deliver the volume and pressure specified by the carmaker for that model – it is a mistake to replace the one on the car.

After the fuel pump and filter on the hydraulic circuit comes the accumulator (these three elements are often lined together in a row on early systems). The accumulator consists of a container with a diaphragm separating the fuel and the air chambers and a spring to hold pressure from the air side of the diaphragm. The functional analogy to accumulators in automatic transmissions is close, but not exact. In

an automatic transmission, an accumulator absorbs and stores the hydraulic application pressure to soften and extend clutch or band engagement time. On a K-Jet, the fuel pressure accumulator absorbs and stores the fuel pressure, but to smooth out the pressure peaks resulting from pressure pulses from the pump (reducing noise and smoothing fuel flow) and to retain pressure in the system when the pump turns off. If you measure the system pressure after the engine shuts off, you should find at least 2.7 bar after 10 minutes and 2.6 after twenty. Not all K-Jet systems require fuel pressure accumulators because in some vehicles there is enough volume in the lines and components.

As mentioned earlier, K-Jet injectors release fuel anytime the pressure is greater than about 3.8 bar (varies somewhat by model and year). But that leaves sufficient residual pressure in the system to keep it primed for a quick restart and to prevent vapor lock in almost any ambient or underhood temperature.

If you find a K-Jet system that does not hold pressure after shutdown, especially if it makes audible 'electric-motor' noise corresponding to pump speed, check the pressure accumulator for a broken spring or ruptured diaphragm. A direct pressure check is the test procedure, and you can measure that most conveniently at the fuel distributor inlet. Inspect the pump's check valve as well by confirming that the system holds pressure after engine shutdown. If those components are good, look for a dribbling injector.

As the gasoline continues through the line, it encounters one of the most interesting devices in automotive technical history, the K-Jet fuel distributor. The name suggests that, like an ignition distributor sorting high-voltage spark to the appropriate plug in firing order, the fuel distributor sorts metered quantities of fuel to the corresponding cylinders. But it doesn't work this way: Instead, all the cylinders get fuel all the time. The distribution in question is sorting the same quantity of fuel to each cylinder simultaneously. A K-Jet bank of injectors can hold the cylinder-to-cylinder mixture variation to six percent or lower. Carburetors typically varied by 40 to 60 percent (see "What Happened to Carburetors?" p. 12).

The fuel distributor has a separate delivery tube for each cylinder's injector. Inside the distributor, each fuel line ends in a differential-pressure regulator metering fuel into its line, based on the fuel pressure and on the amount of deflection of the spring-steel diaphragm below it. While all the pressure regulators share the same hydraulic force in the conjoined lower chambers, they have separate chambers above, each filled through its own laser-cut metering slot. They deliver a precisely equal quantity of fuel to each cylinder because of the precisely equal machining of the components (the control plunger and its sleeve, a matched set, are machined to an accuracy of 0.00025-in).

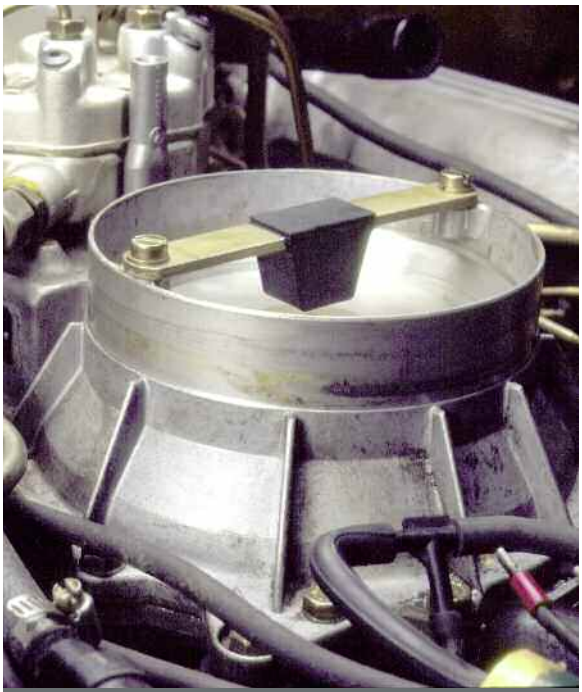
KE-Jet

This level of precision depends critically on the assembly conditions and controls at the factory, so you are most unlikely to succeed in reassembling a fuel distributor on a workbench and have it work properly – or even just not leak. It's interesting to pop a defective one open just to see what's inside, but don't count on using that one again! If you find one plugged internally, get a replacement and return that one for remanufacture. You can remove the inlet filter (if present) or the control plunger and the filter surrounding it and the metering slots for cleaning, but these are not standard maintenance procedures. If you do find particles in those filters, replace the main filter because it's leaking grit through.

Each of the fuel injection lines ends in the center of a small, fuel-filled chamber with a steel diaphragm on the bottom. Below that diaphragm is another chamber of the same dimensions but without an injection line. When there is higher pressure above the diaphragm than below, the force bends the diaphragm slightly down and drives fuel through the fuel line and (assuming it exceeds the opening-pressure threshold) out the fuel injector tip. When the pressure difference between the two matching chambers is lower, the diaphragm moves back up and reduces the amount of fuel injected. If the pressure in the lower chambers is greater, the steel diaphragm rises and shuts off fuel flow entirely. The pressure of the fuel and the vacuum in the intake manifold also affect the fuel volume. Keep in mind, it is the pressure differential between the chambers that determines the diaphragm position, not the pressure itself. But for a given diaphragm position

or injection-line opening, the upper chamber pressure (with the intake manifold vacuum) determines the momentary volume of fuel flow.

The K-Jet airflow sensor is unlike any intake-air measurement device on any other system, even the swinging-door sensor on Bosch L-Jet systems, which it vaguely resembles. The fuel distributor and the airflow sensor are one assembly, described jointly as the mixture-control unit. The K-Jet airflow sensor physically, mechanically determines the fuel flow by changing the pressure in the upper chambers of the fuel distributor.



Airflow plate

The airflow side of that unit consists of a finely machined air cone with an air flap in the center. This air flap occupies a position in the intake airflow between the air filter and the throttle plate, and the flap moves in response to air moving past it, drawn into the engine when the throttle opens. Movement of the air plate corresponds to the volume of air passing it because of the very precise tapering of the air funnel. The open cross-sectional area around the cone reflects the volume of air, and the mixture control unit thus insures there will be a larger quantity of fuel metered for a correspondingly larger amount of air and vice-versa. As the air plate and lever move from the rest position, the lever moves the control plunger to uncover more of the fuel control slots, increase the pressure in the fuel distributor and the amount of fuel delivered.

There is seldom any reason to loosen or remove the K-Jet airflow plate from its lever because its precise centering is so critical (if it touches, it can snag and stick in the funnel bore). If you need access to any part of the airflow sensor below the plate, you have to remove the sensor from the intake tract anyway. Unless you have a special tool for the purpose, a good way to re-center the plate if you have removed it is to fit paper around the perimeter while you tighten the positioning bolt. If you use paper of the uniform, correct thickness, you'll then have a uniform, correct gap all around the sensor plate. Absent that perfect paper, use toilet paper: It will be too thin alone, but you can build up enough for the right gap with further wraparounds.

Air inlet

Mercedes-Benz K-Jet airflow plates usually have curved or shaped top surfaces, not a feature of all Bosch K-Jet systems. The effect of the curved surface is to aerodynamically allow through greater airflow compared to a flat sensor plate of the same diameter. Each airflow sensor plate also has a stop bar above it, combined with a rubber bump-stop. The purpose of those elements is to allow the lever and plate to bounce above the center of the funnel and spill backpressure should there be a backfire through the intake manifold. With these elements, the airflow plate and lever can survive a backfire, usually without damage. The funnel is tapered above, partly to orient the incoming air around the plate and partly to provide pressure relief should there be a backfire.

While Bosch K-Jet systems on many cars draw the intake air up through the airflow sensor and through a tube to the throttle body, on most Mercedes-Benz vehicles the air flows down through the air funnel and into the engine. Among other advantages, this eliminates 'false air' coming

through a cracked, porous or loose air hose. Functionally, the system works the same way with just a change in the geometry of the air sensor lever and fulcrum. While the air flap does present an obstruction to the intake airflow, its aerodynamic resistance is quite low, so there is no vacuum to speak of generated between it and the throttle plate. All of the intake, except for what comes through the PCV and EGR, passes the airflow sensor. Idle air, in particular, transits the sensor.

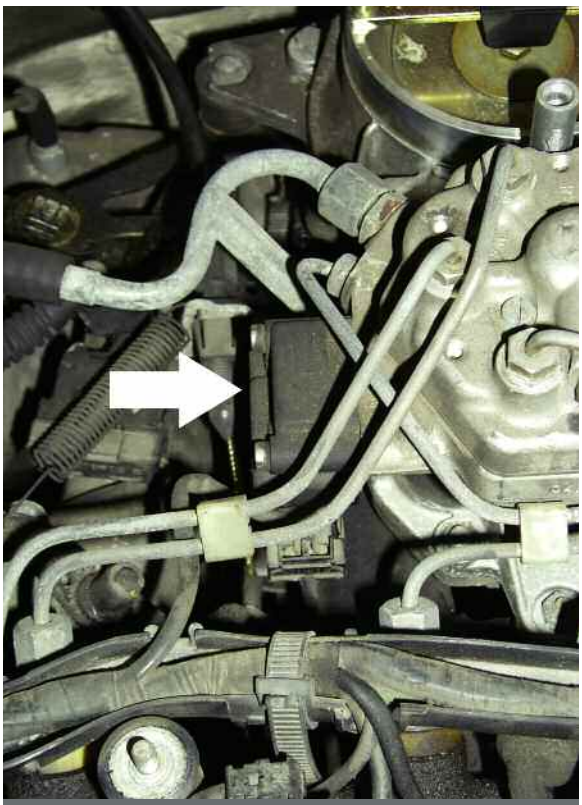
At engine-shutoff rest, with no air passing through the sensor, the spring tension and weight on the arm bring the lever to a position in which it moves the control plunger of the fuel distributor to shut off all fuel flow. While early and late fuel distributors have different internal plumbing, most of them have fuel system pressure above the control plunger, and the return force of the airflow arm must be enough to overcome this as well. Depending on the application, this return force comes either from a spring or from a counterweight on the opposite end of the lever.

As emissions requirements tightened, there was a late version of the K-Jet system, sometimes called the K-Lambda, that used an oxygen sensor for mixture feedback information and a separate frequency valve on the fuel return circuit. By duty-cycling the return flow, the system could fine-tune intake mixture by fine-tuning the fuel pressure in the fuel distributor. But to achieve the combustion control required for the next set of emissions standards, the system had to evolve into the KE-Jet.

KE-Jetronic Fuel Injection and the EHA

What distinguish the basic K-Jet injection system from the KE-Jet are the electrohydraulic actuator (EHA) and the subsystems and components involved in making it work. Because of a pressure regulator in the fuel distributor, the pressure difference between the upper and lower chambers stays about 0.4 bar, the same as the earlier K-jet. As the airflow lever moves, the control plunger routes fuel into the fuel distributor. What the EHA does is to modify the lower chamber pressure in response to the oxygen sensor feedback signal, independently of the rest of the fuel distributor. Modifying the lower chamber pressure changes the pressure differential between the chambers, changes the position of the spring-steel diaphragm and thus changes the volume of fuel delivered for the amount of air passing the airflow sensor.

The EHA contains a variable electromagnet moving a metering plate that covers or uncovers a fuel inlet to the lower chambers. This electromagnet, like all others, is a current-responsive element. It does not work in direct response to voltage, but to amps – or in this case milliamps. The windings on most KE-Jet EHA's should read about 19.5 ohms at room temperature.



EHA

The KE-Jet system does use a control unit to control intake mixtures and keep the combustion as close to stoichiometry as possible (as did the last versions of the K-Jet). The feedback information to constantly readjust this mixture comes from the oxygen sensor just as on most other vehicles. What is different on the KE-Jet is the way the mixture command works. In effect, what it's doing is to control in part the flow of fuel to the lower chambers, thus controlling the pressure differential.

The EHA is a kind of electrical solenoid, but instead of moving an element suddenly and dramatically to one extreme of its travel or the other the way a starter solenoid does, the EHA merely applies a measured electromagnetic force to the metering plate, slightly bending it in one direction or the other. By varying not only the current but also the polarity of the command, the computer can change the mixture from full rich to fuel shutoff (under extended deceleration, for example). The important

thing to keep in mind is that electromagnetism here, as in all solenoids, functions by current, by amperage alone. The voltage does not matter at all, except that polarity cycles back and forth under closed-loop driving; and if polarity changes, voltage does, too.

Check an EHA for continuity as described above and then for dynamic function. When the engine first starts cold, there will be a steady current of several milliamps to richen the mixture for the cold engine. Once the system is running in closed loop (two minutes after startup, at the longest), you should see the current cycling, reflecting the signal from the oxygen sensor cycling. Many testers display this as an on-off signal, but it's actually current in milliamps reversing polarity.

If the EHA current cycles, but not within the milliamp-or-two range, check first for air leaks. If they are eliminated, you can open the 'tamper-proof' cap and have access to the mixture adjustment screw. This should not be a regular service – if the engine has not been apart or the fuel distributor replaced, keep looking for a vacuum leak first. If you use a sensitive amp-clamp to check the EHA at work, be sure to separate the two wires. It doesn't matter which you measure, but if you catch them both in the clamp, the currents in opposite directions will cancel out your measurement.

The KE-Jet ECU employs several parameters when calculating the EHA control current. These include:

Cranking signal – an electrical signal parallel to the starter solenoid current,

Engine temperature – a reference signal dropped to a voltage corresponding to the engine coolant's temperature,

Intake air temperature – from a sensor in the air intake duct,

Engine speed (TD or crankshaft position signal) – from an inductive signal generator at the flywheel,

Engine load – from a MAP (manifold absolute pressure) sensor,

Airflow sensor position signal and movement – from a sensor at the end of the airflow sensor lever pivot,

Oxygen sensor or Lambda signal – from a conventional heated oxygen sensor in the exhaust stream.

For warmup, the computer sends a command current that moves the EHA valve plate to somewhat restrict fuel flow. That allows pressure to drop in the lower chambers, and the pressure differential bends the metal diaphragm down, allowing relatively more fuel to flow. When the engine reaches normal operating temperature and runs in closed loop, the ECU sends commands of varying polarity and current, causing the valve plate to cycle back and forth across its travel, thus richening or leaning the intake mixture as the need reflected in the oxygen sensor signal requires. A scope, set to monitor the EHA current and the oxygen sensor signal simultaneously, graphically indicates this interdependence.

When the computer's sensors indicate deceleration (closed throttle, high engine rpm, strong intake manifold vacuum or low MAP), the ECU sends current in a polarity to pull the metering valve plate all the way back, allowing pressure to equalize between each of the chambers. The additional pressure of the small spring in the lower chamber is then enough to stop fuel flow.

The system has an inherent and transparent 'limp-home' mode. If one or more circuit failures mean the computer can't send a signal to the EHA, spring tension on the valve plate brings it to a center position; and the engine continues to run just as if it had ordinary K-Jet instead of feedback-modulated KE-Jet. On most models this circumstance trips the CEL and, if the car has self-diagnostics, sets a code for whatever circuit has failed. Because the KE-Jet uses an electrically triggered cold-start injector spraying into the intake manifold log, the engine can ordinarily still start when cold.

The computer control system on KE-Jet is almost entirely for the fuel mixture; its purpose is to calculate and send the current command current to the EHA. While it has an input signal from the crankshaft position sensor and in some models from the speedometer, while on some models it includes a transmission upshift delay function (to speed engine warmup), this is not yet a complete engine management system, coordinating fuel, spark, A/C compressor engagement, cruise control and other functions into one (that comes with the next system, Motronic). Control of the ignition system rests with the EZL/AKR control unit, with only minor interconnections with the fuel system. KE-Jet is a fuel injection system only. Nonetheless, do not connect or disconnect the control unit with the ignition key on. That can yield damaging voltage spikes.

Rich and Lean Mixtures

You need more fuel during cranking and the first second or two running. Fuel enrichment continues for as long as two minutes, depending on coolant temperature. It also occurs during acceleration to accommodate the fact that air accelerates into the

intake manifold more quickly than fuel. Finally, at high speeds and high loads, at or near WOT, the mixture also goes rich. In that latter mode, there is no mixture feedback function and no EHA control current; the engine runs in open loop.

The mixture goes lean not only during deceleration fuel shutoff (a throttle-closed microswitch provides the enabling signal) but, on many models, to prevent over-revving the engine into redline territory. It's also the first tactic in the vehicle maximum speed limit, followed by shutoff of the fuel pump. Since the vehicle maximum speed is a voluntary limit agreed among Mercedes-Benz and several other German carmakers for vehicles intended for the unlimited-speed German autobahns, the limit is as high as 250 km/h, about 155 mph. On American roads, this should rarely inconvenience a driver. Deceleration fuel shutoff is disabled whenever the car is under cruise control.

CTS for fuel and ignition

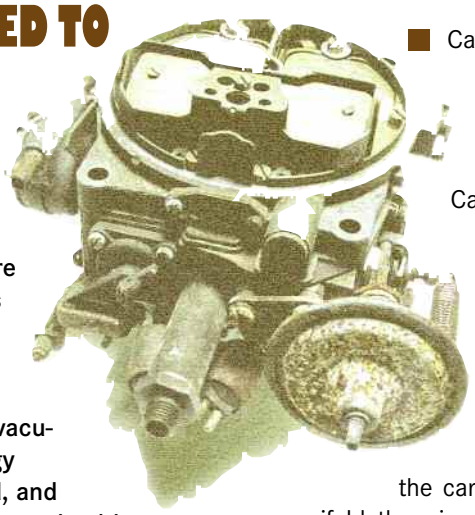
You can find any one of three different coolant temperature sensors on Mercedes-Benz cars with KE-Jet: an internally grounded one-pin version connecting only to the KE control unit, a similar two-pin unit with pins for the KE and ignition control units (or one for KE and one for the fuel pump relay) or a four-pin version with two pins for KE and two for the ignition system. All use NTC resistors; that is, the resistance goes down as the temperature goes up. The four-pin versions are idiot-proof, in the sense you can plug them in any clock position and they work the same. Each second pin on the four-pin versions avoids any problem of excess resistance on the ground-return circuit. For each type of sensor, though, check the continuity of the harness back to the computer as well as the variable resistance through the sensor.

There is no throttle position sensor, but there is a throttle switch with two outputs, corresponding to idle position, WOT position or (in the absence of either) any position in between. Because of the way the KE-Jet airflow sensor and fuel distributor work, there is no need for a fine-discrimination throttle-position potentiometer. Test these switches, simple on-off devices, for continuity in one position and open circuit in the other.

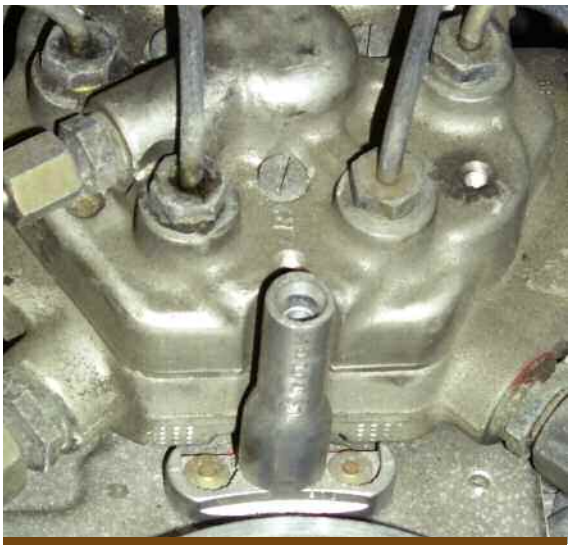
Throttle switch

As important as K-Jet and KE-Jet are in the development of Mercedes-Benz fuel injection systems (and for other carmakers, actually), it's critical to understand how the original systems worked to understand the later variations, what the changes were for, what they meant. What a good thing that every new technology has to start with the simplest version!

WHAT HAPPENED TO CARBURETORS?



Why did carburetors go away? They were essential parts of cars practically as long as tires, and (like every thing else) they'd become more complex even as the demands of fuel economy, power and emissions friendliness increased. Even on the most complicated carburetors, the vacuum and evaporation technology involved were well understood, and most vehicles could run well enough with them, even if overhaul and readjustment procedures became gradually more difficult.



Mixture control tower

The carburetor's insoluble problems were with mixture control and fuel distribution. The proper fuel/air ratio for an engine varies considerably over load, speed and temperature. It varies also with the 'recent history' of the throttle, too, so you need a richer mixture at a given throttle position if the driver is in the process of rapidly opening it, and you need a much leaner mixture at the corresponding throttle positions as the throttle rapidly closes. Most carburetors used an acceleration pump or its equivalent to briefly richen the intake mixture as the driver moved the pedal toward the floor. The enrichment provided by the accelerator pump, however, was imprecise and changed over time with wear of the pump.

Carburetors could vary mixture in response to oxygen sensor feedback signals, but at the cost of increased complexity and vulnerability to dirt or contaminants. Carmakers used duty-cycled solenoids to modulate either the fuel in the main circuits or the air in the emulsion tubes. A feedback carburetor, however, could not make mixture changes rapidly enough to follow rapid openings or closings of the throttle with the precision required. What's more, since the carburetor sits on 'top' of the intake manifold, there is no way to prevent the fuel just atomized and vaporized from condensing back into liquid on the manifold walls when pressure and temperature conditions favored that. Even the most sophisticated mixture-adjusting carburetor could hold total mixture within the desired range only at steady speeds, not under the quick changes of driving in ordinary traffic.

But even if the mixture problem were perfectly solved for carburetors, there is still the fuel distribution problem. This is most dramatic on inline engines with single carburetors and 'log' manifolds: Imagine a six-cylinder engine with a single-barrel carburetor at the midpoint of an intake manifold running parallel with the camshaft. Because the heavier droplets of fuel resist turning when the airflow does, most blow to the extreme ends of the manifold. The smallest droplets and the properly vaporized fuel make the turns easiest. In every such engine, then, cylinders one and six will get the richest mixtures and cylinders three and four will get the leanest.

This is more than a slight or theoretic problem, actually. According to Bosch experiments, a typical carbureted four-cylinder engine will have mixture variations of about 60 percent. Clearly, you have to send the cylinders getting the leanest mixture enough fuel to fire dependably; thus the richest cylinders must always run overrich. This condition means increased wear in those rich cylinders because of cylinder wall washdown from the excess fuel. It is typical in inline engines to find the first and last cylinders have the most wear (though there are other factors, like variations in coolant temperature as you get closer to or farther from the water pump).

The richer mixture naturally enough means more hydrocarbons in the exhaust, too. Multipoint fuel injection systems like the K-Jets reduce both mixture and distribution problems by a factor of about 90 percent.

AD

Multilink Suspensions

How to discern, diagnose and repair suspension problems when they occur…

Almost all Mercedes-Benz cars built since the middle 1980's have used similar suspension geometry, particularly for the rear suspension. This geometry, beginning with models 201 and 124, is among the simplest and most successful of all multilink suspensions (though perhaps it is odd to describe any multilink suspension as simple). Here we'll look at why the design is used, at how it works and how to discern, diagnose and repair problems when they occur.

Independent and Multilink

First, let's glance over the reasons for independent multilink suspension so we understand what it's supposed to do. The original vehicle suspensions were on oxcarts, with solid axles bolted solidly to the wagon they supported. If you really want to 'feel the road,' you can't beat a solid, unsprung axle: You'll get feedback from every twig and pebble; if you drive over a coin, you'll know whether it was heads or tails. At any speed, you'll get compression damage to your spine and coccyx, too. This impact is not only uncomfortable for the driver, it quickly destroys the vehicle and its load, too, unless it's heavy and overbuilt or moves so slowly the road-slams linger over time. Roman centurions stood rather than sat in their war chariots not just because they were macho and studly, but also because that let them bend their knees to accommodate the jolts and lurches of the unsprung vehicle. Riders of stiff-sprung motorcycles today stand on the footpegs while crossing railroad tracks for the same reason.

Leaf springs, mounted either longitudinally or laterally, were a great improvement over that. With enough suspension travel, they could allow the vehicle to traverse very rough surfaces with at least fewer hard slams against the frame itself. Pioneers traveling in Conestoga wagons, however, preferred to walk alongside, and not just to relieve the horses of some load – walking was more comfortable than riding.

Automotive applications of leaf springs achieved a much higher level of success. In fact, for carrying very heavy loads even today large trucks almost uniformly use either solid axles and leaf springs or, to attune suspensions to load, solid axles with variable-pressure airbag springs. Cars, however, seldom carry loads several times the vehicle's empty weight; and we expect not only a more comfortable ride, but optimized traction and directional control as well. Hence modern passenger vehicles generally use independent suspensions and coil springs. Such arrangements eliminate the effect one wheel bouncing on an axle can have on the opposite side, reduce the unsprung weight (wheels and tires, brakes and axles, everything that rests on the ground side of the springs) to a minimum, so the road-induced oscillations of the suspension itself affects the passenger compartment as little as possible.

Multilink suspensions ratchet the handling objectives up in a new way. Not only do we want a smoother ride, with less bumping and lurching; we also want better performance and safety. An optimized independent suspension can reduce the perceived inertial effect of bumps, but it does not automatically optimize traction and control. If you think about it for a moment, the only reason a Roman chariot had any traction or control at all was because the centurion's horses had independent, multilink suspensions (and because horses are heavier than chariots with centurions).

Optimized Wheel Position

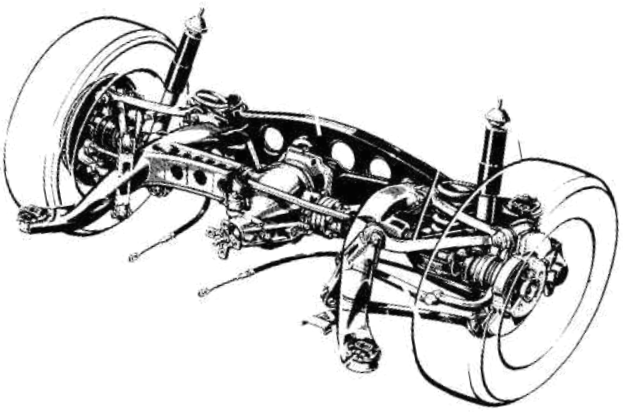
For any vehicle, for any load and for any combination of speed and radius in a turn, there is a unique, optimal position for each wheel and tire with respect to the pavement. This position maximizes the tread-patch contact area with the pavement and sustains a predictable and continuous influence on the directional control of the car.

While you can predict some of these positions (we'll surely want the wheels pointing straight ahead and angled perpendicular to the pavement when driving in a straight line), determining most of the others requires extensive testing and experiment. For example, you want the rear outside wheel to gradually angle inward, to toe inward, as the vehicle leans to that side in an increasingly steep turn. You want this because the contact patch in a turn does not move parallel to the centerline of the wheel, but gradually angles inboard as the turn steepens, up to the point when traction goes away. This keeps the turning angle of the vehicle kinetically or tactually predictable to the driver. However, you don't want that toe change to continue up to the point when the vehicle suddenly spins. Rear wheel traction must always exceed front wheel traction for obvious reasons of safety.

Similarly, most cars corner somewhat better if the outside wheels pick up a few degrees of negative camber in a turn, to offset the effect of the tilting tire sidewalls. Engineers specify the dynamic suspension angles like caster only after extensive research. When you do your first Mercedes-Benz alignment, you'll be surprised at the specified caster angle if you learned alignment on domestic vehicles. Some of the older models called for as much as 12 degrees positive. The higher speeds at which people drive in Germany require a much larger caster angle than is common here to ratchet the steering stability high enough for those speeds.

Traction in turns is not the only objective of multilink design. With careful design of the geometry, the front suspension can resist dips under braking, and the rear can resist dips under acceleration. Braking and acceleration forces also raise the suspension with a force proportional to the acceleration change by the twisting effect they have on the knuckle. Keeping the suspension height level keeps the tiretread geometry straight and square with the road under both acceleration and braking, optimizing traction for both. An anti-dive suspension, in other words, can actually reduce braking distance since it keeps the tiretread flat against the pavement. Similarly, antisquat rear-suspension geometry can improve traction for acceleration. In each case, the height correction maintains the camber on that axle constant. Finally, the right multilink geometry allows the effective employment of truly effective, active suspension systems taking the control of traction and handling to yet a new level (largely quick-adjusting dampers, but also some height adjustment).

Rear Suspension



Enough for the theory and the objectives, let's look at the parts on the car. The rear suspensions of all current Mercedes-Benz cars share the same five-link geometry. The parts, to be sure, are not interchangeable between models, but the geometry is, as we learned in high school, congruent.

The five links are:

Spring Link

This is the lowest and largest link in the suspension, pivoted inboard at the differential/rear axle subframe and outboard where it forms a yoke with the knuckle of the axle. A bit inboard of the center of the link is the cavity for the bottom of the coil spring, the cavity that gives the link its name. A protective cover bolts to the underside of the spring link, fending off road debris. That protective cover also works as a reliable indicator if there has been collision damage: Since it is the lowest part of the suspension, it is the most likely to encounter an obstacle, and being lighter it will bend or crack before the spring link will.

Camber Link

Directly above the driveaxle and the spring link is the camber link, connecting the upper part of the subframe to the upper part of the knuckle. Its function is to keep the tire vertical with respect to the pavement as the vehicle corners or leans.

Tie Link

The shortest of the five links extends from an arm on the knuckle to a flange at the front of the rear subframe. This link controls the rear toe and thrust line. You make adjustments at the eccentric bushing at the front of the link.

Pushing Link

Running forward from the lowest part of the knuckle to the subframe, the pushing link transmits the drive forces from the knuckle forward to the body of the car. When the driver accelerates, the final, delivered engine torque applies to the vehicle mostly through the pushing link.

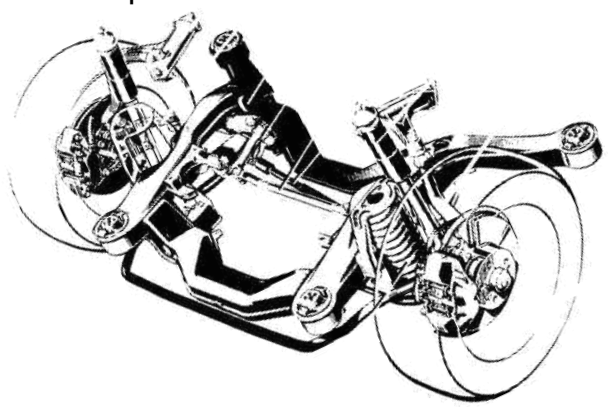
Pulling Link

Connecting the forward top part of the knuckle, immediately adjacent to the outboard end of the camber link, to the upper, forward part of the subframe, the pulling link transmits braking force as well as holding the knuckle vertically steady.

Secondary Components

The swaybar and its bushings are above the drive axle but connect through the yoke at the outboard side of the spring link to the knuckle. Most Mercedes-Benz technical literature refers to the swaybar as a “torsion bar.” The driveshafts themselves are also, in a way, links between the differential and the wheels.

Front Suspension



The current Mercedes-Benz front suspension looks simpler than the rear, though there are several variations. All share a lower wishbone with the damper strut as far outboard as is compatible with clearing the wheel and tire. The springs are as far inboard as possible to reduce their share of the unsprung weight. You make the alignment adjustments through eccentric inboard bushings and at the tierod ends. The swaybar extends across the front of the suspension.

Certain models, beginning with the 140, use a small control arm at the top of the damper strut to better optimize caster and camber in certain driving modes. Some experienced mechanics find the angle of that small control arm is the quickest indication of any problem with suspension height, such as sagging springs. It pivots back as well as up in its normal travel, so once you've seen a few 'known-good's' one that's out of adjustment will leap out at you.

Alignment procedures

The linkage geometry may be complex, but adjustment procedures generally are not. You set caster and camber, front and rear, with the eccentrics (changing both at the same time!). Then you set the rear toe with the eccentric on the tie link, and once the thrust line is correct, set the front toe with the adjustable tierods.. If an eccentric adjustment can't bring the system into specification, something is either worn beyond use or broken. Damaged struts are visible by comparison to the mirror-image strut on the other side; worn bushings will be visibly different from the others. Oil and heat damage should be evident to an experienced eye.

Subframes

The suspension does not support the body of the car directly. In each Mercedes-Benz, the suspension connects to a subframe through hard-rubber bushings, which in turn supports the body through other hard-rubber bushings. Much of the vehicles' quiet running comes from this suspension and drivetrain bushing design. The engine and drivetrain also rest on the subframes on a third set of hard-rubber blocks, and this separation of the body from the suspension and drivetrain and their isolation from one another reduces the transmission of vibrations from the engine and from the road. Rubber and rubber/antifreeze bushings hold the major components at an effective, vibration-damping setoff. The antifreeze retains the advantages of liquid damping when temperatures fall below freezing.

The rear suspension shares the same indirect connection to the body through a bushed subframe. The rear subframe supports the body, but it also supports the differential with separate rubber bushings. The suspension links attach to the same subframe in several positions, as we'll see below.

Critical as the subframes are, you should inspect them carefully for damage, especially for cracks, which can sometimes close up and hide when the weight is off the wheels. Rustproofing and accumulated dirt can conceal such cracks. Ball joints are subject to normal wear. Mercedes-Benz carries a simple go/no-go gauge to test them.

Sometimes people decide to add their own 'edge' to the alignment specifications to give a car a particular ride, by tweaking the front camber and the like. This is not a particularly good idea with Mercedes-Benz cars. The company does a great deal of research in handling and suspension, and their German domestic customers expect the cars to drive in control even at high speeds and under challenging road conditions. Unless your customer weighs 400 pounds and always rides alone or is an anvil peddler with a trunk full of samples, you should

There are a large number of accessories that, on one model or the other, connect to different suspension links and components. Some are as familiar as ABS wheelspeed sensors; some are as unusual as the switch on the 129 (SL) rear linkage that triggers the roll bar up if the rear wheels leave the ground. Many Mercedes-Benz cars have different forms of active suspension (varying the shock damper rates), suspension height adjustment (some cars crouch down an inch or so closer to the highway for better aerodynamics at high speeds), sensors for locking differentials and more. If you find such a component in your way, determine what it is and how to remove it without causing unexpected problems later. In subsequent articles and issues, we'll get to all the Mercedes-Benz vehicle systems, but for now we're just looking at the multilink suspension basic geometry.

There are several other safety-related issues: Many Mercedes-Benz vehicles have diagonal cross-braces below the floor, particularly roadsters and convertibles. These function to keep the body stiff and square under driving stresses. Be sure you have the body supported equally and level at the designated jacking points before you remove these cross-braces. If not, there could be body damage in some other area of the car, and you may find it very difficult to get the cross-braces and their fastener bolts back into the right positions.

That applies to potential damage to the vehicle. This applies, in addition, to potential personal injury. Remember, only the damper struts hold the springs in place on these suspensions, when the car is on a lift and the suspension is at full extension. The front geometry vaguely resembles a MacPherson strut, but that's not what it is. If you remove the damper strut without restraining the spring in a spring compressor, the spring can fly out of the seat with unexpectedly great force. Mercedes-Benz dealers carry spring compressors and model-specific end flanges that make this critical step safe and easy.

Finally, here's a general precaution that doesn't apply to vehicle or personal safety, but could make the difference between a satisfactory job and one you have to do over free. Multilink suspensions include a large number of bushings, at least one at either end of each link. Many of these links are clock-position specific, and many such specific clock positions are very easy to confuse with others for similar vehicles. For instance, suppose you're replacing front control arm bushings on a 201 and using the clamping sleeve replacement bushing. On the forward front control arm bushing, the flat spots in the bushing go vertical [position for line drawing P33-2053-13] and the rear flats go horizontal, toward the center of the car. On a 124 or 129, however, you put the rubber flats vertical on the rear pivot of the control arm, and turn the front bushing flats horizontal toward the center of the car, just the opposite of what you do on the 201.

Now, nobody can remember all this accurately. That's why we have reference materials and technical libraries. The point is, when you see a Mercedes-Benz bushing that is not perfectly symmetrical in every orientation, that means there is one correct and many incorrect ways to install it. Failing to find and observe that right orientation means the bushing will have a different and unpredictable elasticity than the engineers designed for that linkage pivot. The car will drive measurably worse than it did when new.

If you've worked on suspensions for any length of time, think of this as a reminder, not as nagging: When you've replaced a suspension bushing – any suspension bushing – lower the car's weight onto the wheels so the bushing is under its normal rest load before you tighten the fastener (to the proper torque specification). This avoids giving the bushing an unintended twist, which can shorten its useful life as well as make it behave oddly. Bushings are the most important parts of any multilink suspension, and their correct assembly is the most important part of suspension work.

PARTS NEWS

Classic Car Service Manual CD's

When this project is complete, there won't be any difficulty getting full service manual information for any model Mercedes-Benz, going back to 1947. The Mercedes-Benz technical information department has prepared CD's with all the information formerly available only through books and microfiche. CD's for models 107, 114/115, 116, 123, 124 and 201 are ready now, and more will be ready in the near future, beginning with model 126.

The information has been scanned from the original sources and can be accessed from any computer using Microsoft Internet Explorer 4.0 or later or Netscape Navigator 4.0 or later. The information contained on the disks includes all the information relative to the carmodel throughout its entire production run. While the focus is on vehicles built to the specifications of the American market, there is additional information for features of vehicles built for the European roads.

The CD's contain all the pages from the appropriate engine manuals, electrical troubleshooting manuals, maintenance manuals, owners manuals, climate control manuals and chassis/body manuals. This combines in one place all the information previously available from many sources. The CD's can thus be of advantage not only to shops performing repairs and service on these models, but to those engaged in restoration or other detailed work on the cars.

Mercedes-Benz Remanufactured Parts Lineup Gets Even Larger

Mercedes-Benz USA is pleased to announce that we have made an already impressive lineup of remanufactured parts even stronger with the addition of wiper motors and brake calipers.

Our goal is to be your first and last source for replacement parts for Mercedes-Benz vehicles. Expanding our already impressive line of remanufactured parts is just another tool we can give you to satisfy your customers.

Because the reputation of our cars rests on the quality of our parts, you can be assured that Genuine Remanufactured Mercedes-Benz parts are carefully built in tightly controlled factory conditions. When a component is replaced, it is replaced with a new Genuine part, not an aftermarket knockoff. If you aren't buying your remanufactured parts from us, you don't know what you are getting. Why take chances with unknown quality control?

The warranty on Mercedes-Benz remanufactured parts is for 12 months, unlimited mileage from the date of purchase. Remanufactured automatic transmissions are warranted for 24 months or 24,000 miles, whichever comes first, from the date of purchase. Engines and long blocks are warranted for 48 months or 50,000 miles, whichever comes first, from date of installation as of May 20, 1996.

AD

STARTUNED

FACTORY SERVICE BULLETINS

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

Restart delay relay Models 201, 124 and 126

To prevent clash between the starter drive and the ring gear/flexplate teeth, many but not all models 201, 124 and 125, beginning in 1989, have a timer relay that prevents a second cranking attempt for a period of two seconds after one that fails to start the engine. The purpose is to allow the crankshaft to come to a complete stop before the starter drive re-engages the ring gear/flexplate teeth. OK, so far so good. But here's the problem: If the relay fails, you can get another relay from your Mercedes-Benz parts supplier. If the harness fails, however, you must either repair the harness, or if that proves impossible for some reason, you must wire around the relay. There is no replacement harness.

First, confirm that you have a car with the crank-delay relay. In each of these line drawings, it is relay N38.

If you want more detail on how to wire around the relay, see Electrical Troubleshooting Manual, p. 113 model 124, p. 105 model 126.

MBNA 15/45

Moisture in fuse and relay box Model 124

A leak in the fuse box lid or through the rubber boot around it may allow moisture to collect in the fuse box, a condition that could eventually lead to corrosion and harness component failure. If you find a car with that condition, first remove the fuse and relay carrier and dry all the components and the fuse box. Replace any parts damaged by the water. Then drill a 6 mm hole in the place indicated in the illustration, the lowest point in the fuse box [P00.00-1072-01 or photograph]. Check the fuse box cover and the gasket and seal all the rubber boots on the box for leaks with sealing compound as needed.

AF00.00-U-4040AU

Central locking system does not work below freezing All models

Moisture is getting into the system through one or more leaking elements and then forming a pneumatic block when it turns to ice with the cold. First perform vacuum and pressure leak tests to locate and repair the leaks by replacing the defective components. Then blow out all the lines individually with dry compressed air or a commercial nitrogen gas drier. Remove any working elements with water in them from the vehicle, turn them upside down and actuate each about five times. Shake all the remaining water out and repeat the process until they're completely dry.

AF80.20-U-4010A

Mercedes-Benz Service Information Website

Mercedes-Benz is committed to keeping you informed as we move forward in the Information Age. That's why we are happy to announce a planned Mercedes-Benz website jam-packed with service information, technical data and much more, all accessible by members of the independent vehicle repair industry.

So stay tuned with StarTuned, your Mercedes-Benz technical and parts information connection.

Cylinder head bolt notes
All models

Everyone knows not to use impact wrenches to tighten cylinder head bolts, but on Mercedes-Benz engines don't use them to remove the bolts, either, to protect the threads in the block. Many engines are aluminum or other thinwall castings, so it is also critical to insure the boltholes are completely emptied of oil and antifreeze before head bolts are reinstalled. Blowing such residue out with compressed air is usually a satisfactory technique, but inspect each hole to confirm removal of any dirt or liquid. If fluids are left at the bottom of the bore, tightening the bolt could create enough hydraulic pressure to crack the block.

MBNA 01/6

Overrevving damage to torque converter
All models with automatic transmissions

Running an engine beyond redline can damage the engine by floating or bending valves, twisting connecting rods and other equally dire consequences. To prevent that, Mercedes-Benz engines have included maximum engine speed limiters for many years. Those protective measures, however, can only prevent redlining the engine using the throttle. If a driver manually downshifts the transmission at too high a speed, this could result in the vehicle's momentum spinning the crankshaft above a safe speed.

Besides the damage to the engine potentially resulting from a speed above redline, the torque converter can also distort by centrifugal force acting on the transmission fluid in the converter, 'ballooning' the converter up. The distortion takes the form of thickening the torque converter, this making it interfere with the front transmission pump and damage the front seal. If an engine has sustained overrevving damage, check the torque converter by placing it on a flat surface with the pump-drive side down. Measure the thickness from the surface to the attachment bolt surface as shown in the illustration [p27-2371-13]. As long as the thickness is 121.5 mm or less, the torque converter is satisfactory; if it is thicker than 121.5 mm, replace the converter.

MBNA 27/82

Oxygen sensors
All models

If an oxygen sensor doesn't send a proper cycling signal or the vehicle's self-diagnostic memory records an oxygen sensor fault, confirm that the oxygen sensor is properly grounded before you replace it. Not only must the sensor make a secure electrical connection to the exhaust system; the exhaust system must also make a secure electrical connection through the engine cylinder head to the negative terminal of the battery. Confirm also that the computer shares the same ground as the oxygen sensor does. Only if the groundside of the circuit is good but you don't find a signal from the sensor, should you replace the sensor.

MBNA 07.3/11

EGR functional test
All models with EGR

Everybody knows that the diaphragm on an EGR valve must hold vacuum built with a hand pump or else the valve is defective, but you'd like to know the valve works actively as well. Once you've confirmed the diaphragm is intact, release the vacuum suddenly. If the valve works as it is supposed to, you'll hear an audible pop from the valve as the pintle snaps closed.

MBNA 14/6

Hood hinge test
All models

Here's a quick and accurate test to see whether a hood hinge has been damaged on a Mercedes-Benz vehicle: Place a short (150 mm) ruler or straightedge against the outside surface of the hinge, with the hood at the 45-degree position. If the gap between the hinge and your straightedge is 0.0 to 0.2 mm or less, the hinge is good. If the gap is greater, the hinge is bent.

MBNA 88/32

Too clean for safety
All models

Keeping a car clean and polished not only makes it easier on the eye and a source of greater satisfaction for the owner; it also helps prevent rust and abrasion to

the paint and other surfaces. But some people get carried away with vehicular tidiness. If you use a pressure washer to clean the wheels and tires, use only a wide, fan-shaped nozzle and keep the tip of the tool constantly moving and at least 12 inches from the tire. A round or pencil blast nozzle can cause pinpoint overheating of the sidewall rubber from high-speed vibration, causing hardening and damage that will not appear until later. Such a nozzle can cause invisible tire damage even at a distance of 30 inches. And a sidewall blowout is not something tidy!

MBNA 40/99

Steering idler freeplay Models 124, 126, 129 and 201

You should only replace steering linkage idler gear rubber bushings under one of two conditions:

- The bushings are making noise when you turn the steering from lock to lock.
- The total freeplay in the idler arm is more than 0.5 mm as measured at the point where the tie rod connects to the outer end of the idler arm. Use a suitable clamp-on dial indicator to make the measurement.

MBNA 46/72

Engine shuts off, can't restart Vehicles with gasoline engines

It is possible for the oxygen sensor signal wire to rub against the driveshaft on some Mercedes-Benz vehicles. If the spinning driveshaft wears through the insulation on the wire, this can damage the oxygen sensor and short the printed circuit in the fuel pump relay. Repair requires replacement both of the sensor and the relay. Be sure to route the sensor wire so the problem cannot recur.

07.3-88041

Panel bulb breaks speedo cable? Models 124 and 201

It's not a very plausible claim, is it? But any attempt to remove the instrument panel, even partially, can damage the accelerator cable, even if you're just tilting it enough to reach in and swap a burned-out indicator bulb. Before you pull the instrument panel loose, disconnect the speedometer from behind. You don't want to have to try to explain how the burned out bulb broke the speedometer cable!

MBNA 54/58

Trunk hard to close in winter Model 201

If it becomes difficult to close the trunk lid on a Model 210 during very cold weather, inspect the condition of the two rubber bumpers at the trunk latch. The rubber bumpers can become very hard at low temperatures, making the trunk difficult to close. Just remove one of the rubber trunk latch bumpers to reduce the problem by exactly half!

AF88.50-U-60001A

No start Engines 102 and 103

Add to your no-start checks this one: If there was a backfire the last time the engine was running, it is possible the molded hose at the idle air valve (above) fell off, allowing excessive unmeasured air into the intake manifold. While you're inspecting that hose, confirm that it does not have damage from being swollen or cracked.

07.3-90011

Headliner removal/replacement Model 124

The traditional way to remove a car's headliner is through the rear window, or 'backlight.' The one-piece headliner installed in the M-B 124 from January 1991 on comes out the front passenger door, instead. Here's how:

- Remove the door frame protection edge from all four doors.
- Remove the windshield moldings from the A-pillars.
- Remove the roof frame panel trim above the windshield.
- Remove the trim panels from the B-pillars.
- Remove the trim panels from the C-pillars.
- Remove the rear interior lamp and assist handles above the doors.
- Move the front seats to their rearmost position and lower the backrests completely.
- Put the gear selector lever in Park.
- Slide the headliner rearward and unhook it from the roof frame. There are two retaining clips.
- Remove the headliner through the front passenger door.

SI 68/18 March 1991

Wood console removal Model 129

You really, really don't want to damage the wood paneling on M-B consoles and dashboards because they actually are wood, all from the same tree for a given car. The likelihood of finding a panel that will match exactly is exactly zilch. This means it's important to use the proper techniques when removing these panels. We'll fill you in on them in future issues. Here's how to remove the center console of the Model 129 without putting yourself in the market for some very expensive lumber:

With the ignition off and the parking brake applied, pull the radio using the radio removal keys. Disconnect the electrical connectors.

Reach through the radio opening and push the climate control push-button unit outward. Disconnect its electrical connectors.

With an automatic transmission, remove the plastic trim ring around the selector lever and move the lever to position 2. With a manual transmission, disengage the bottom of the shift boot and move the lever into a rearward gate position such as third gear.

Remove the screw in the center of the storage compartment. Bend the upper corners of the storage compartment inward (arrows) and press the compartment forward, removing it by the corners. Don't use a sharp edged tool when removing the compartment to avoid damaging the wooden cover. Lift the cover only with a small removal hook on the screw hole of the compartment housing.

Remove screws 2 and 3 below the storage compartment.

Press the rear of the console wooden cover left to disengage the catch and lift the right side. Press the rear right to disengage the catch and lift the left side. Lift the rear cover and pull downward out of the upper catches.

Disconnect the wiring connectors from the switches.

Remove the wooden cover.

When reassembling everything, check that all the switches and components work. You'll have to recode the radio.

MBNA 68/4

Convertible top care and neglect All models with soft top

Here are a few useful rules for M-B soft top owners:

- Never take the car through an automatic car wash. Never use high-pressure cleaning equipment to wash the soft top.
- Remove all bird droppings immediately. Acids can quickly damage both soft-top material and even body paint.
- Never use ice or snow scrapers or other tools with sharp edges.
- Normally just rinse the soft top with water. Wash it only if it is "significantly" dirty.
- Do not use gasoline, thinners, tar removers, stain removers or other organic solvents when cleaning the soft top.

If the soft top must be cleaned, do the following:

- Clean the top only when it is closed and locked.
- Sweep the soft top with a soft brush while dry.
- Mask all adjacent paint and glass surfaces, including plastic windows.
- Wash with a generous amount of lukewarm water and a neutral detergent.
- Always brush or sponge in the same direction, front to rear.
- Use detergent concentrate only on extremely dirty areas or white/grey patches where there has been contact or chafing.
- Thoroughly rinse with clean water.
- Let the soft top dry completely before putting it down.

MBNA 77/37

Soft top control modules Models 124 and 129

It may sometimes happen that soft top control modules fail and must be replaced. But this is not the case, in general, with modules that have various DTC's stored in memory, DTC's that suspend operation of the soft top. DTC's that can have this effect are:

DTC's 3, 18, 20-24

DTC's 21,22, 26, 30

Before replacing a soft top control module, always record what is in fault memory, erase the memory, test drive the vehicle for more than 10 seconds, open and close the soft top. Then read out the DTC memory again.

If there is a problem during soft top operation, hold the switch until the indicator lamp begins blinking. If the previous DTC's can be erased, soft top operation is possible; that is, the fault is no longer present. DTC 30, however, can be stored again while driving.

MBNA 77/9

Window adjustment Model 129

Air and water leaks around the windows can often be corrected by readjusting the position of the windows in the doors. Install the hardtop to provide a fixed surface to adjust the window to. Then remove the inner door panel, the lower body protection panel and the speaker group and air passage. Remove the protective plastic liner from the door as well as the inner and outer sealing rail. If the door is not perfectly square in its frame, adjust the door so it is in the correct position.

That done, loosen the guide piece screw and push it downward. Remove the rubber plugs and loosen both 13 mm nuts. Turn the 5.5 mm adjustment bolts so the screws of the guide rail are in the middle of the bracket.

Adjust the window with the front and rear sliding blocks so the window rests parallel and in the middle of the window channel in the lowered position. It should be 9 mm from the door inner metal panel. The later gap (which translates into the tension) increases as you push the blocks upward and decreases as you lower them.

Loosen the front and rear upper stop bracket nuts. Close the window until the leading edge is flush with the rearview mirror bracket. If the window is correctly adjusted, the upper edge should contact the inner lip of the window seal along its entire length. Tighten the front and rear nuts on the upper stop bracket. Check the window position did not change when you re-tightened things. You make the adjustments by moving the rear screw of the window lifting guide rail and at the front stop for the upper travel limit.

Adjust the angle and lengthwise position of the window by loosening the three screws on the window-lifting rail. Once that adjustment is correct, tighten the front and rear screws on the window-lifting rail. Re-install the outer and inner sealing rail.

Adjust the later inclination, the preload, of the window against the sealing frame of the hardtop using the 5.5 mm adjustment screws on the front and rear bearing block of the vertical guide rail. The upper leading edge of the window should directly touch he window seal with the window fully up and the door engaged to the first latch. Tighten the 13 mm locknuts.
Adjust the rear guide rail through the oblong hole so when the door closes completely the vertical edge of the window touches the hardtop rubber seal for its entire length. Adjust the lower travel limit by first adjusting the stop on the window lifter and then on the lifter rail so the upper edge of the window closes flush with the sealing rails. Adjust the stop on the window lifter rail so the limit switches on the right and left in the bottom door recess engage simultaneously when you lower the window completely.

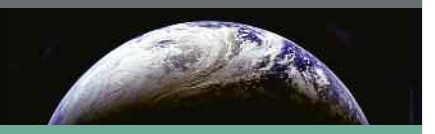
Adjust the guide piece by moving the screw in the oblong hole so when the window is in the upmost position the vertical edge of the window just touches the guide piece. Once the adjustments are complete, lubricate the sliding surfaces with M-B lubricating paste (part number 001 989 14 51). Finally, reinstall all the door trim pieces.

Selective unlocking Model 163

Before attempting to repair a radio frequency key or the locking system with which it works, it is well to understand how the system functions since it is not possible to alter the system to behave in some other, possibly simpler way. Here is how it works: If you press the unlock button once, the driver's door and the fuel filler flap unlock. If you press the unlock button a second time, all the doors plus the tailgate and fuel filler flap unlock. An attempt to make the system do something other than what it was designed to do is not likely to be satisfactory.

T-SI-MBNA-80.35/10

StarTuned



Mercedes-Benz Parts Dealers

Alabama

Dothan
Rahal-Schmitz
334-794-6716

Hoover
Crown Automobile Company, Inc.
205-985-4200

Huntsville
Regal Auto Plaza
256-837-5752

Mobile
McConnell Automotive Corporation
334-476-4141

Montgomery
Jack Ingram Motors, Inc.
334-277-5700

Tuscaloosa
Leigh Automotive
205-556-1111

Alaska

Anchorage
Mercedes-Benz of Anchorage
907-277-3383

Fairbanks
A & B Auto, Inc.
907-456-6161

Arizona

Phoenix
Phoenix Motor Company
602-264-4791

Scottsdale
Schumacher European
480-991-1155

Tucson
Mercedes-Benz of Tucson
520-886-1311

Arkansas

Fayetteville
Jones Motorcars, Inc.
501-521-7281

Little Rock
Riverside Motors, Inc.
501-666-9457

California

Anaheim
Caliber Motors, Inc.
714-777-1900

Bakersfield
Mercedes-Benz of Bakersfield
661-836-3737

Belmont
Autobahn Motors
650-637-2333

Beverly Hills
Beverly Hills, Ltd.
310-659-2980

Buena Park
House of Imports
714-562-1100

Calabasas
Calabasas Motorcars, Inc.
818-591-2377

Carlsbad
Hoehn Motors, Inc.
760-438-4454

Chico
Courtesy Motors Auto Center, Inc.
530-893-1300

Encino
Auto Stiegler, Inc.
818-788-0234

Escondido
Mercedes-Benz of Escondido
760-745-5000

Fremont
Claridge's Ltd.
510-623-1111

Fresno
Herwaldt Motors
559-438-0300

Glendale
Calstar Motors, Inc.
818-246-1800

Laguna Niguel
Mercedes-Benz of Laguna Niguel
949-347-3700

La Jolla
Heinz Gietz Autohaus, Inc.
858-454-7137

Long Beach
Mercedes-Benz of Long Beach
562-426-7301

Los Angeles
Downtown L.A. Motors
213-748-8951

Modesto
Modesto European
209-522-8100

Monterey
Stahl Motor Company, Inc.
831-375-2456

Newport Beach
Fletcher Jones Motor Cars, Inc.
949-718-3000

Oakland
Mercedes-Benz of Oakland
510-832-6030

Palm Springs
Mercedes-Benz of Palm Springs
760-328-6525

Palo Alto
Park Avenue Motors
650-494-0311

Pasadena
Rusnak/Pasadena
626-795-8004

Pleasanton
Mercedes-Benz of Pleasanton
925-463-2525

Riverside
Walter's Auto Sales & Service, Inc.
909-688-3332

Rocklin
Van Housen Motors
916-924-8000

Sacramento
Mercedes-Benz of Sacramento
916-924-8000

San Diego
Mercedes-Benz of San Diego
858-279-7202

San Francisco
Mercedes-Benz of San Francisco
415-673-2000

San Jose
Smythe European, Inc.
408-983-5200

San Luis Obispo
Kimball Motor Company
805-543-5752

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

Santa Barbara
Cutter Motors
805-682-2000

Santa Monica
W.I. Simonson, Inc.
310-829-4511

Santa Rosa
Smothers European
707-542-4810

Stockton
Berberian European Motors
209-944-5511

Thousand Oaks
Silver Star A.G. Ltd.
805-371-5400

Torrance
Mercedes-Benz of South Bay
310-534-3333

Van Nuys
Keyes European
818-997-8700

West Covina
Penske Motorcars
626-859-1200

Walnut Creek
Stead Motors of Walnut Creek
925-937-1655

Colorado

Colorado Springs
Phil Long European Imports L.L.C.
719-575-7950

Denver
Murray Motor Imports Company
303-759-3400

Littleton
Mercedes-Benz of Littleton
303-738-7700

Connecticut

Fairfield
Mercedes-Benz of Fairfield
203-368-6725

Greenwich
Mercedes-Benz of Greenwich
203-869-2850

Hartford
New Country Motor Cars, Inc.
860-522-6134

New London
Carriage House of New London, Inc.
860-447-3361

North Haven
Mercedes-Benz of North Haven
203-239-1313

Delaware

Milford
I.G. Burton & Company, Inc.
302-424-3042

Wilmington
Wilmington Motor Cars, Inc.
302-995-2211

Florida

Clearwater
Lokey Motor Company
727-530-1661

Coral Gables
Bill Ussery Motors, Inc.
305-445-8593

Daytona Beach
Mercedes-Benz of Daytona Beach
386-274-4775

Ft. Lauderdale
Mercedes-Benz of Fort Lauderdale
954-462-4381

Ft. Myers
Mercedes-Benz of Fort Meyers
941-433-8300

Ft. Pierce
Coggin Motor Mall
561-466-7000

Ft. Walton Beach
Quality Imports, Inc.
850-863-2161

Gainesville
Kraft Motorcar Co., Inc.
352-332-7571

Jacksonville
Brumos Motor Cars, Inc.
904-724-1080

Lakeland
Robert G. Waters, Inc.
863-688-8111

Maitland
Mercedes-Benz of Orlando
407-645-4222

Melbourne
Continental Motorcars, Inc.
321-956-0600

Miami
Mercedes-Benz of Miami
305-919-8000

Naples
Regency Autohaus, Inc.
941-643-5006

Pensacola
Centennial Imports, Inc.
850-432-9903

Pompano Beach
Autohaus Pompano
954-943-5000

Sarasota
Glauser, Inc.
941-923-3441

St. Petersburg
Crown Eurocars, Inc.
727-526-3738

Tallahassee
Capital Eurocars, Inc.
850-574-3777

Tampa
Mercedes-Benz of Tampa
813-870-0010

West Palm Beach
Mercedes-Benz of Palm Beach
561-689-6363

Guam

Tamuning
Atkins Kroll, Inc.
671-646-2360

Georgia

Albany
Hentschel Motorcars, Inc.
912-883-2040

Athens
Mercedes-Benz of Athens
706-549-6600

Atlanta
Carriage House Imports, Inc.
770-964-1600

Atlanta
RBM of Atlanta, Inc.
770-390-0700

Augusta
Rader, Inc.
706-860-1111

Columbus
Columbus Motor Company
706-327-3636

Decatur
Atlanta Classic Cars, Inc.
404-296-1313

Macon
Jackson Automotive Group, Inc.
478-477-4858

Savannah
Critz, Inc.
912-354-7000

Hawaii

Hilo
Theo Davies Euromotors, Ltd.
808-961-6087

Kailua-Kona
Theo Davies Euromotors, Ltd.
808-329-7616

Honolulu
Theo Davies Euromotors, Ltd.
808-592-5600

Idaho

Boise
Lyle Pearson Company, Inc.
208-377-3900

Pocatello
Park Price Motor Company
208-232-1062

Illinois

Arlington Heights
Mark Motors, Inc.
847-259-4455

Barrington
Motor Werks of Barrington
847-381-8900

Bourbonnais
Napleton's Autowerks
815-933-8221

Champaign
Sullivan-Parkhill Imports, Inc.
217-352-4161

Chicago
Loeber Motors, Inc.
312-944-0500

DeKalb
Sawyer Auto Imports, Inc.
815-758-5451

Lake Bluff
Knauz Continental Autos, Inc.
847-234-1700

Lincolnwood
Loeber Motors, Inc.
847-675-1000

Loves Park
Napleton's Autowerks, Inc.
815- 636-6600

Marion
Foley-Sweitzer Motor Sales, Inc.
618-997-1313

Naperville
Mercedes-Benz of Naperville
630-305-4560

Normal
Sud's Motor Car Company, Inc.
309-454-1101

Northbrook
Autohaus on Edens, Inc.
847-272-7900

Orland Park
Mercedes-Benz of Orland Park
708-460-0400

Pekin
Mid/Town Imports Incorporated
309-347-3191

Peru
J.P. Chevrolet GEO Nissan Company
815-223-7000

Springfield
Isringhausen Imports, Inc.
217-528-2277

Westmont
Laurel Motors, Inc.
630-654-8100

Indiana

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D-Patrick, Inc.
812-473-6500

Fort Wayne
Shaver Imports
219-432-7200

Highland
Terry Shaver Imports, Inc.
219-924-2400

Indianapolis
World Wide Motors, Inc.
317-580-6800

Lafayette
Mike Raisor Imports
765-448-4582

Mishawaka
Gurley Leep Motorwerks, Inc.
219-256-1500

Iowa

Center Point
Areson Motors
319-849-1233

Davenport
Lujack's Northpark Auto Plaza
563-388-8610

Des Moines
European Motorcars Des Moines
515-278-4808

Kansas

Shawnee Mission
Aristocrat Motors
913-677-3300

Topeka
Sunflower Motors, Inc.
785-266-8480

Wichita
Scholfield Auto Plaza, L.L.C.
316-688-5000

Kentucky

Ashland
Sim Fryson Motor Co., Inc.
606-329-2288

Bowling Green
Bowling Green Imports
270-745-0001

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James Motor Company
606-268-1150

Louisville
Tafel Motors, Inc.
502-896-4411

Louisiana

Alexandria
Walker Automotive
318-445-6421

Baton Rouge
Audubon Imports
225-296-7290

Lafayette
Moss Motors
337-235-9086

Metairie
Benson Motor Company
504-456-3727

Shreveport
Holmes European Motors, Inc.
318-212-1212

Maine

Bangor
Quirk Auto Park of Bangor
207-941-1017

Falmouth
Performance Motors
207-781-3207

Maryland

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Mercedes-Benz of Annapolis
410-268-2222

Bethesda
Euro Motorcars, Inc.
301-986-8800

Cockeysville
Valley Motors, Inc.
410-666-7777

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Mercedes-Benz of Hagerstown
301-733-2301

Owings Mills
R & H Motor Cars, Ltd.
410-363-3900

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Pohanka TM, Inc.
410-543-3411

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Herb Gordon Auto Group, Inc.
301-890-3030

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Boston
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617-469-1000

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508-869-6766

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Black Forest Motors
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Grand Blanc Motorcars, Ltd.
810-695-4400

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616-241-2671

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Orrin B. Hayes, Inc.
616-345-0167

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Mercedes-Benz of Novi
248-426-9600

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Williams Auto World
517-484-1341

Rochester
Mercedes-Benz of Rochester
248-652-3800

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Maplewood Imports
651-483-2681

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Sears Imported Autos, Inc.
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Mississippi

Gulfport
Bert Allen Imports
228-864-6622

Jackson
Higginbotham Automobiles, L.L.C.
601-956-4211

Missouri

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Legend Automotive Group, Inc.
573-875-5000

Creve Coeur
Plaza Motor Company
314-301-1715

Ellisville
Tri-Star Imports, Inc.
636-458-5222

Joplin
Tri-State Import Cars, Inc.
417-781-1177

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Elite Automotive Group
417-889-5750

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DeMarois Olds-GMC Company
406-721-4000

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Lincoln
Husker Auto Group. Inc.
402-434-5100

Omaha
Mercedes-Benz of Omaha
402-384-9999

Nevada

Las Vegas
Fletcher Jones Imports
702-364-2700

Reno
Streeter Imports
775-322-3700

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Greenland
Dreher-Holloway, Inc.
603-431-8585

Manchester
Holloway Motor Cars
of Manchester, LLC
603-669-6788

New Jersey

Bridgewater
Millennium Automotive Group
908-685-0800

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Mercedes-Benz of Cherry Hill
856-663-3200

Edison
Ray Catena Motor Car Corp.
732-549-6600

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Benzel-Busch Motor Car Corp.
201-567-1400

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Globe Motor Car Company
973-227-3600

Freehold
David Michael Motor Car Corp.
732-462-5300

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Mercedes-Benz of Princeton
609-771-8040

Little Silver
Contemporary Motor Cars, Inc.
732-842-5353

Millville
Joseph Pontiac-GMC-Oldsmobile
609-825-7070

Morristown
Mercedes-Benz of Morristown
973-267-9200

Newton
Intercar, Inc.
973-383-8300

Paramus
Prestige Motors, Inc.
201-265-7800

Union
Ray Catena Motor Car Corp.
908-964-4000

W. Atlantic City
Precision Cars of Atlantic City Corp.
609-645-9000

New Mexico

Albuquerque
Premier Motorcars, L.P.
505-821-4000

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Helms Brothers, Inc.
718-631-8181

Binghamton
Feduke Motors, Inc.
607-772-0700

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Sovereign Motor Cars, Ltd.
718-258-5100

Fayetteville
Romano Motors, Ltd.
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Estate Motors, Inc.
914-232-8122

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Keeler Motor Car Company
518-785-4197

Long Island City
Silver Star Motors, Inc.
718-361-2332

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Mercedes-Benz of Nanuet
845-623-1500

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Mercedes-Benz Manhattan, Inc.
212-629-1600

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Holtz House of Vehicles, Inc.
716-424-4740

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Lakeview Auto Sales & Service
516-766-6900

Roslyn
Rallye Motors, L.L.C.
516-625-1600

Smithtown
Competition Imports, Inc.
631-265-2204

Southampton
Mercedes-Benz of Southampton
631-283-0888

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Friendly Motorcars
845-298-0600

White Plains
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914-949-4000

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Mercedes-Benz of Buffalo
716-633-0088

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Skyland Automotive, Inc.
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Charlotte
Beck Imports of the Carolinas
704-535-6400

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336-856-1552

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Hendrick Motors
828-322-5640

Raleigh
Leith, Inc.
919-876-5432

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Bob King Autohaus
888-469-2369

Winston-Salem
Mercedes-Benz of the Triad
336-760-4580

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Valley Imports, Inc.
701-277-1777

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330-733-7511

Bedford
Motorcars East
440-439-0100

Canton
Kempthorn Motors
330-452-6511

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Ross Motor Cars
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Mercedes-Benz of Cincinnati
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614-299-2144

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Crown Eurocars
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419-885-5111

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Coppus Motors, Inc.
419-447-8131

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Leikin Motor Companies
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330-793-2444

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Mercedes-Benz of Oklahoma City
405-236-1224

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Jackie Cooper Imports
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Dave Holt, Inc.
541-382-4040

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Mercedes-Benz of Eugene
541-687-8888

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Crater Lake Motors, Inc.
541-773-3673

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Mercedes-Benz of Portland
503-228-8351

Salem
Valley Motor Company
503-585-1231

Wilsonville
Mercedes-Benz of Wilsonville
503-454-5000

Pennsylvania

Allentown
Knopf Automotive
610-439-1555

Camp Hill
Sun Motor Cars, Inc.
717-737-3030

Devon
Mercedes-Benz of Devon
610-687-1500

Doylestown
Keenan Motors
215-348-0800

Erie
Contemporary Motorcar Ltd.
814-868-8622

Ft. Washington
R & S Imports, Ltd.
215-646-7700

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Mercedes-Benz of Lancaster
717-569-2100

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Bud Smail Motorcars, Ltd.
724-838-1200

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Tom Masano, Inc.
610-777-6587

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Leitzinger Imports, Inc.
814-238-2447

Washington
John Sisson Motors, Inc.
724-206-6000

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Brandywine Motor Cars
610-696-1220

Wexford
Bobby Rahal Motorcar Company
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Wilkes-Barre
Motorworld Auto Group, Inc.
570-829-3500

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Garage Isla Verde, Inc.
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Inskip Autocenter
401-821-1515

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Conway
Fowler Motors, Inc.
843-347-4271

Florence
Newsome Automotive
843-662-8711

Greenville
Carlton Motorcars, Inc.
864-213-8000

Hilton Head Island
Modern Classic Motors, Inc.
843-681-8500

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Vern Eide Motorcars, Inc.
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Long of Chattanooga
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Kingsport
Rick Hill Imports, Inc.
423-224-2660

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865-777-2222

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Mercedes-Benz of Memphis
901-345-6211

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Mercedes-Benz of Nashville
615-742-8000

Texas

Austin
Mercedes-Benz of Austin
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Mike Smith Autoplex
German Imports, Inc.
409-840-2000

Bedford
Park Place Motorcars
Mid-Cities, Ltd.
817-571-3737

Corpus Christi
Ed Hicks Imports
361-854-1955

Dallas
Park Place Motorcars
214-526-8701

El Paso
Mercedes-Benz of El Paso
915-778-5341

Harlingen
Cardenas Autoplex, Inc.
956-425-6000

Houston
Mercedes-Benz of Houston Greenway
713-986-6400

Houston
Mercedes-Benz of Houston North
281-885-6000

Houston
Star Motor Cars
713-868-6800

Laredo
Powell Watson Motors, Inc.
956-722-5182

Midland
Britt Imports, Inc.
915-699-7993

Plano
Ewing Autohaus
972-599-0909

San Antonio
Mercedes-Benz of San Antonio
210-366-9600

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Pete Mankins Pontiac-Cadillac, Inc.
254-793-5661

Tyler
Classic-Tyler Motors, Inc.
903-581-0600

Waco
Allen Samuels Chevrolet-GEO
254-772-8850

Wichita Falls
Patterson Auto Center
940-766-0293

Utah

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Ken Garff Imports
801-521-6111

Vermont

Shelburne
The Automaster
802-985-8482

Virginia

Arlington
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703-525-2100

Charlottesville
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804-817-3380

Fredericksburg
Noble Cars, Inc.
540-373-5200

Hampton
Tysinger Motor Company, Inc.
757-865-8000

Lynchburg
Kenneth Hammersley Motors, Inc.
804-385-6226

Richmond
David R. McGeorge Car Co., Inc.
804-755-9300

Roanoke
West Motor Sales
540-344-6284

Vienna
H.B.L., Inc.
703-442-8200

Virginia Beach
Phillips Automotive, Inc.
757-499-3771

Washington

Bellevue
Mercedes-Benz of Bellevue
425-455-8535

Bellingham
Wilson Toyota
360-676-0600

Fife
Mercedes-Benz of Tacoma
253-922-6820

Pasco
McCurley Imports
509-547-5555

Seattle
Phil Smart, Inc.
206-324-5959

Spokane
Sutherland Motors, Ltd.
509-455-9100

Yakima
Hahn Motor Company
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304-746-0600

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University Motors, Ltd.
304-296-4401

Parkersburg
Astorg Motor Company
304-422-6403

Wisconsin

Appleton
Enterprise Motorcars, Inc.
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Concours Motors, Inc.
414-290-1400

Madison
Z European
608-258-4000

Wausau
Rosemurgy International
Auto Mall, Inc.
715-675-7775

West Allis
International Autos, Inc.
414-543-3000

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