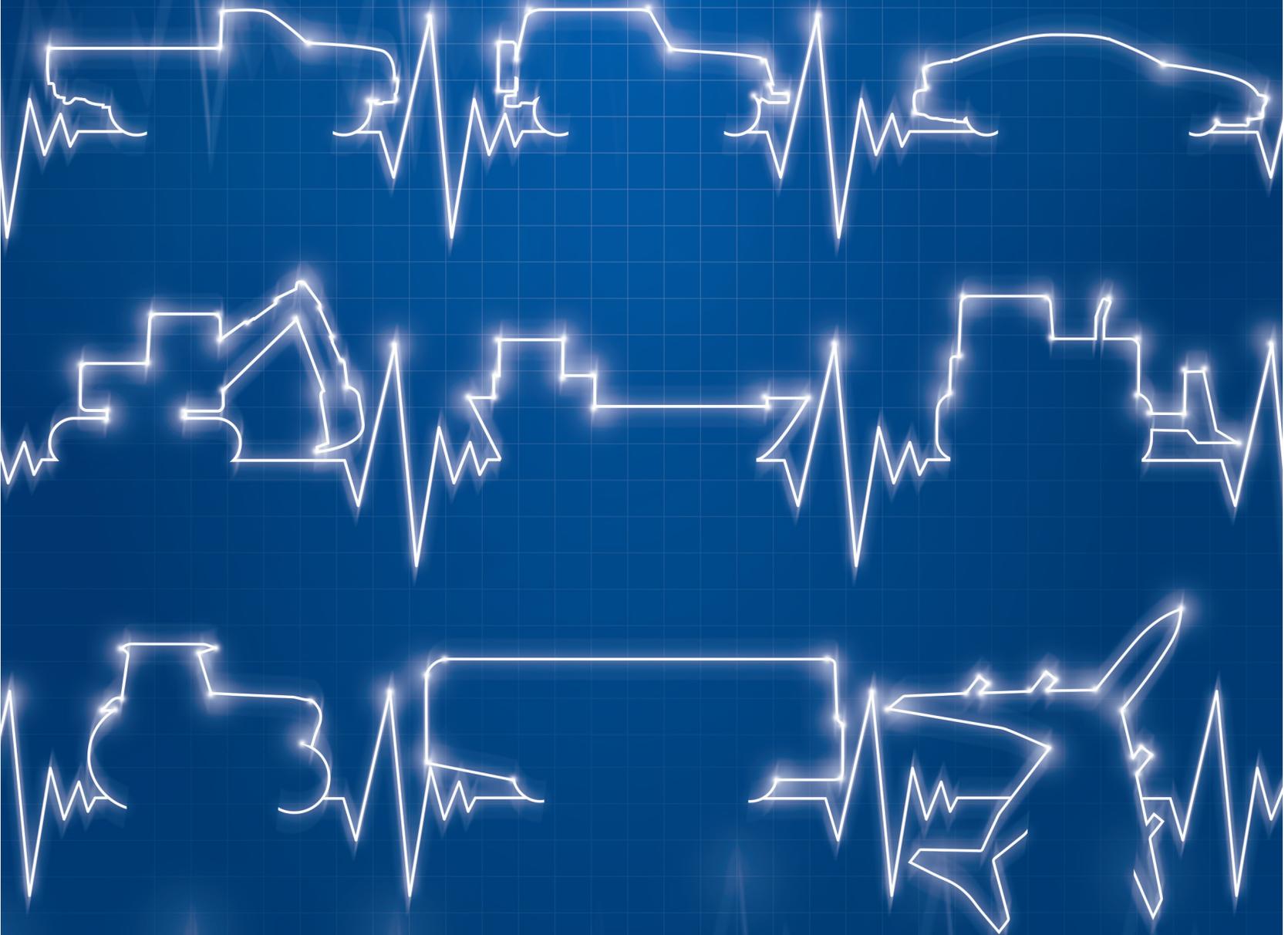




FEDERAL-MOGUL POWERTRAIN

The Heartbeat of Powertrains,
Big and Small.



Product Portfolio
www.federalmogul.com



A Legacy of Quality

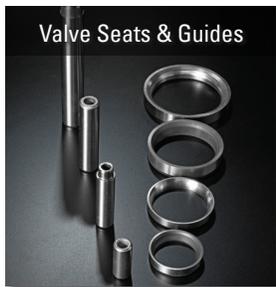
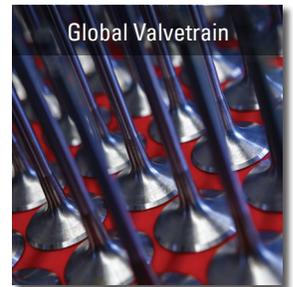
Federal-Mogul Powertrain has developed and delivered innovative technologies meeting specific customer, regulatory and market requirements for over a century. The company's advanced component designs, specialized coatings and proprietary manufacturing processes facilitate friction reduction and extend the capabilities of conventional materials.

- Advanced powertrain component designs and materials enable more efficient propulsion systems and facilitate vehicle light-weighting for improved fuel economy and lower CO₂ emissions
- Powertrain technologies enable optimized friction, supporting engine downsizing, higher compression ratios and improved performance
- Specialized coatings extend the capability of cast iron and aluminum engine technologies, ensure better lubrication and reduce component wear caused by friction



The Heartbeat of Powertrains, Big and Small.

A Global Leader



A Global Presence



A Broad Market Reach

Federal-Mogul Powertrain has a full range of diesel and gas technologies suitable for virtually every industrial and transportation market.

- **Aerospace**
- **Energy**
- **Mining**
- **Agriculture**
- **Forestry**
- **Oil and Gas**
- **Automotive**
- **Hydropower**
- **Off-Road**
- **Commercial Vehicle**
- **Industrial**
- **Rail**
- **Marine**
- **Power Generation**
- **Construction**



The Heartbeat of Powertrains, Big and Small.

Brands You Trust



Engine components for automotive and heavy-duty engines



Self-lubricating sliding bearings for industrial applications



Piston rings for 4-stroke large bore engines and mechanical face seals for axles



High quality sleeving and shielding solutions for bundling and protection against abrasion, heat, noise and electromagnetic interference



Spark plugs and ignition products for automotive applications



DAROS

Piston rings for 2-stroke large-bore engines



Specialized bearings with layers of self-lubricating material



The leading brand of industrial igniters and combustion sensors.



Pistons





Federal-Mogul Powertrain has exemplary expertise in developing next-generation pistons that address high mechanical and thermal loads. Our pistons feature optimized gallery locations for maximum cooling and state-of-the-art processes, technologies, coatings and engineered surfaces.

Light and Commercial Vehicle Aluminum Diesel Pistons

- Advanced horizontal-casting process significantly improves microstructure
- DuraBowl® aluminum remelting process improves the fatigue strength of aluminum pistons to withstand mechanical and thermal loads produced by heavily boosted engines
- Two-dimensional ultrasonic and eddy current inspection technique ensures "defect-free" castings for optimum durability
- Light Vehicle Diesel (LVD) premium alloy with increased durability higher fatigue strength up to 440°C

Light Vehicle Aluminum Gasoline Pistons

- Advanced piston technology for up to 20% lower friction
- EcoTough® low friction, wear-resistant piston skirt coating reduces piston friction up to 10% versus standard coatings
- Patented Elastoal skirt provides the highest strength-to-weight ratio
- Elastoal II ultra lightweight aluminum piston allows a weight reduction of up to 15% in high power gasoline engines
- Elastothermic® gallery-cooled gasoline piston enables downsized engines to run at higher power levels and compression ratios with low NVH and outstanding durability

Light Vehicle Diesel (LVD) Steel Pistons

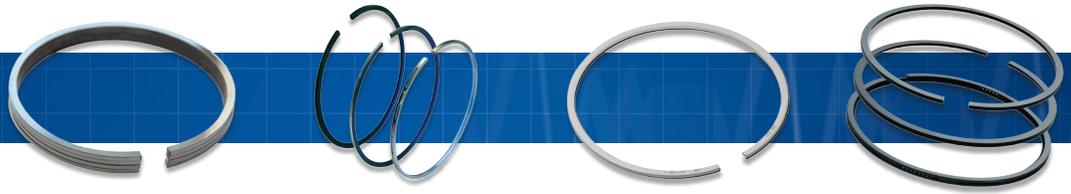
- LVD piston design based on award winning Monosteel® piston
- Advanced welding techniques for steel forgings create the strength and cooling potential of closed galleries
- Reduced compression height facilitates reduced overall engine height

Heavy-duty Industrial Steel Pistons

- Dual friction-welded construction, enabling large cooling galleries for high temperature resistance and strength
- Industry-leading Monosteel® piston is ideally positioned to operate at elevated engine temperatures and pressures
- Monosteel's® unique architecture features large closed structural gallery, full-length skirt and bushingless MnP-coated pin bores
- Reduced groove distortion and improved oil control and gas sealing
- Magnum Monosteel™ piston design enables 17% friction reduction when compared to conventional steel piston designs

Piston Rings





Federal-Mogul Powertrain designs and produces an extensive portfolio of piston rings with advanced low friction coatings. New ring designs and advanced cast iron, cast steel and steel-wire materials reduce oil use, improve combustion chamber efficiency and enable better fuel economy and lower emissions

Gasoline and Diesel Engine Piston Rings

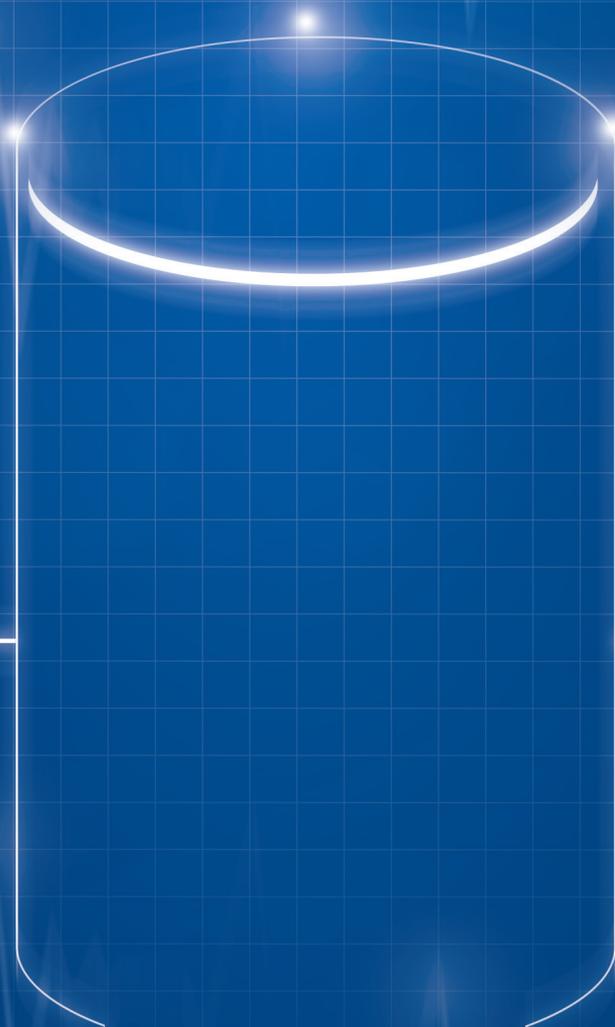
- 2015 PACE™ Award winning DuroGlide® is a unique piston ring DLC coating for diesel and gasoline engines with the lowest friction, excellent lifetime durability and the highest scuff resistance of any piston ring coating
- Unique Physical Vapor Disposition (PVD) ring coatings provide high scuff resistance
- Blitzchrome® ring side face protection provides more than 50% wear reduction compared to non-protected ring sides
- CKS® and Goetze Diamond Coating (GDC®) for piston rings offer very robust ring function with regards to wear, scuffing and oil consumption
- LKZ-Rings® decrease in-cylinder friction 15% and reduce oil consumption 50% due to a stepped and tapered ring land
- CarboGlide® DLC coating reduces ring friction 20% for gasoline and diesel oil rings

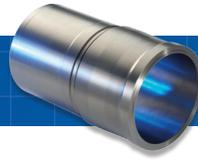
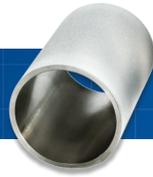
Large Bore Engine Piston Rings

- 145 mm - 980 mm bore size for 4 and 2 stroke engines
- Sophisticated geometries and gas-tight gaps
- Use of CGI, VGI and other advanced grey cast iron materials as well as cast steel
- Plasma, ceramic, chrome-ceramic, GDC® and other coatings



Cylinder Liners





Cylinder Liners for Passenger Cars and HD-Engines

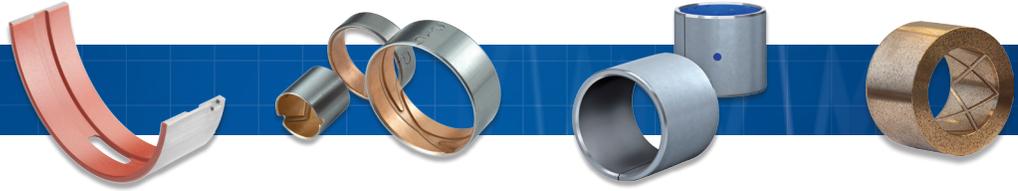
Federal-Mogul Powertrain produces a wide variety of cylinder liners with unique designs to reduce fuel consumption. Our engineers use advanced analysis techniques for distortion reduction and improved piston ring sealing for extreme diesel cylinder pressures.

- Hybrid Liners reduce oil consumption by reducing bore distortion. Material compositions serve all requirements, such as intermetallic bonding for lowest distortions and optimum heat transfer in combination with advanced tribology properties
- Sprayfit® liner combines the advantages of a direct bore coating and liner technology with an ultra-thin sleeve made of sprayed composite material that is inserted using a proven, press fitting process. This provides improved heat transfer to the engine block with benefit for lower oil consumption
- As-Cast Liner Aslock-Type cast iron liner with a special homogenous outside structure enables a very strong interlock between aluminum block material and the cast iron liner



Bearings and Bushings





Pioneering the development of lead-free electro-coating technologies, we continue to push performance boundaries and offer a complete range of lead-free, environmentally friendly components, which are uniquely matched to a variety of applications.

Federal-Mogul Powertrain is the only manufacturer to offer the full breadth of material and manufacturing technologies in its 2014 PACE™ award winning High Performance Lead-Free Engine Bearings, necessary to provide lead-free solutions for the entire global engine and transmission market.

Bearings

- 2013 PACE™ Award recipient, IROX® polymer coating extends lifetime wear by 500% and improves fatigue performance by 20% versus standard solutions
- IROX® bearing shells help to reduce fuel consumption and CO₂ emissions by withstanding mechanical and thermal loads produced by heavily boosted or start-stop engines
- Bearings with partial groove reduce oil pump losses by up to 30%
- Sophisticated flange bearing design is easy to assemble with individual material choice for radial and axial bearing surfaces
- Sputter bearings for ultra high-load applications facilitate significant improvement in fatigue performance over lead bearings
- High Precision Profiling (HPP) technology enables a wide range of custom profiles with absolute precision, a single micron tolerance

Bushings

- Lead-free, bi-metallic bushings meet ever-increasing demands for load capacity, sliding velocity and wear resistance
- Federal-Mogul Powertain bushings provide optimum support under static, dynamic, rotating, oscillating or sliding motion conditions

Glycodur®

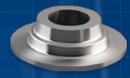
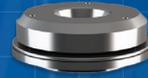
- Precision bearings meet demanding requirements in dry operating conditions or lubricated with oil, grease or fuel
- Glycodur® bearings feature high static and dynamic load capacities, a low wear rate and low coefficient of friction
- Lead-free and produced from environmentally friendly materials

DEVA®

- Self-lubricated bearings for a wide range of industrial applications including construction, hydroelectric power plants, windmills, steel plants, marine, offshore, steam turbines, gas turbines and heavy-duty
- DEVA® bearings meet the toughest demands in maintenance-free and self-lubricating industrial applications
- High-performance bearings feature high wear resistance, low and constant friction, excellent thermal and corrosion resistance, durability and immunity to abrasive particles
- DEVA® bearings are the preferred solution for high temperature, underwater, high edge loads, shock loads and other extreme conditions

Global Valvetrain





Federal-Mogul Powertrain develops and manufactures superior engine valves and valvetrain components.

Our advanced engineering capabilities include design, simulation, testing and investigation using approved measuring devices, resources and methods for design validation and development for valvetrain components for small engines, light-vehicle petroleum, light-vehicle diesel, heavy-duty and large bore engines.

Engine Valves

- Intake and exhaust valves are precision components used for sealing the combustion chamber and controlling the gas exchange process in internal combustion engines
- Basic designs are monometallic, bimetallic and hollow valves
- Designed according to engine application with regard to special load cases like temperature, corrosion, wear resistance and mechanical loads from dynamics and combustion pressure. Valve design and material need to be selected accordingly
- Hollow valves are special bi-metallic valves, filled with sodium, used to reduce the thermal load of the valve head material or for weight reduction. Significant temperature reduction in the underhead area is possible depending on design and thermal load
- Valve lengths range up to approx. 1,000mm

Valve Cotters

- Valve cotters have the task of attaching the valve spring retainer cap or alternatively the rotator to the valve
- Standardized designs (predefined sizes and shapes from 4mm to 108mm stem diameter) but also individual solutions can be offered
- Single-groove clamping cotters present different cone angles and heights to influence the clamping characteristics
- Multi-groove non-clamping cotters, with 3 or 4 beads depending on their size, allow free rotation of the valve stem
- Hardened and not hardened designs specific to customer application
- Cotters are either cold-stamped or turned

Valve Rotators

- Valve rotators like ROTOCAPS® and Rotocoils are used when the mechanical rotation of valves is necessary
- Typically used on stationary and industrial applications, heavy-duty and marine engines to turn the valves constantly
- Forced valve rotation increases valve-life by evenly distributing temperature and reducing wear on the valve seat. It also prevents deposits from forming on the valve seat and may reduce life-cycle costs significantly

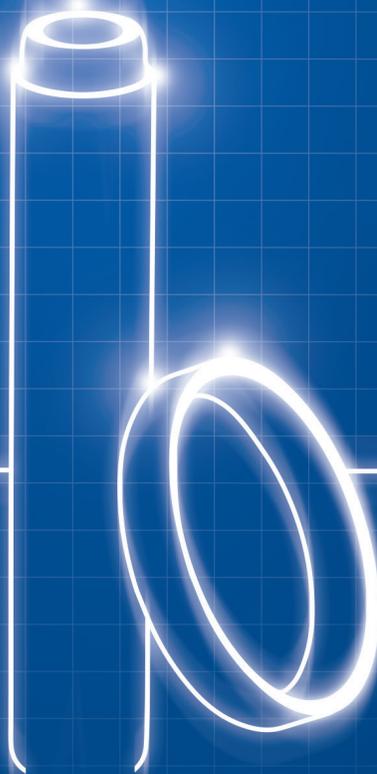
Tappets

- The mechanical bucket tappets are positioned between the camshaft and the valves and are directly actuated by the camshaft. They transmit the movement of the cam to the end of the valve stem, thereby activating the valve
- Coated with a DLC coating with very good adhesion properties, improving wear resistance during the whole engine lifetime combined with a friction reduction of up to 30%
- Several DLC coating types are available and compatible with different engine applications
- Important reduction in friction allowing less fuel consumptions and reduced CO₂ emissions
- Lash adjustment between valve and camshaft is achieved by using different grades of tappets

Retainers

- Spring retainer caps transmit the spring loads to the valve via the valve cotters
- Used both on intake and exhaust side
- Can work in combination with single and double-valve springs
- Cold formed and hardened to resist against high loading

Valve Seats and Guides





Federal-Mogul Powertrain's high performance powder metal materials are tailored to serve the specific and extreme tribological requirements of components exposed to high temperature exhaust gas and combustion environments in demanding downsized and turbocharged applications.

Our valve seat insert, valve guide and turbocharger bushing materials are developed to deliver superior performance in the area of high temperature wear resistance, lubrication and thermo-physical properties. The resulting wear and scuff resistance suit a variety of gasoline and diesel valve train configurations and specific requirements, such as alternative and poor quality fuel operation, reduced fuel enrichment and low-soot combustion.

Advanced valve seat and valve guide technologies enable vehicle manufacturers to achieve CO₂ reduction strategies for new turbocharged, direct injection and ethanol capable downsized, high-output engines.

Valve Seat Inserts

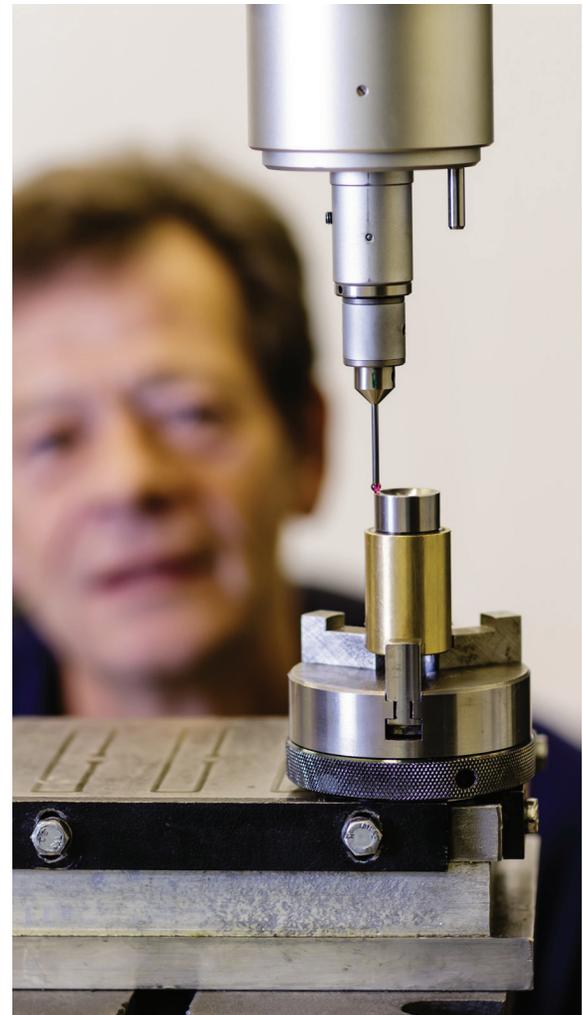
- Specifically developed alloys deliver wear resistance in corrosive EGR diesel engine operating environments
- In-house developed materials such as Lean Tool Steel provide excellent wear performance as a cost effective alternative to conventional tool steel-based materials
- High-duty wear resistant materials in dual-layer configuration for turbo charger diesel in-house developed hard particles ensure best performance-to-cost ratio
- High density, high strength allows mechanically safe operation in the most arduous thermal and mechanical applications

Valve Guides

- Advanced self-lubricating material compositions allow valve guides to perform at higher side loads resulting from valve train influences or cylinder head distortions
- Enhanced lubrication extends the operating temperatures by as much as 100°C and delays valve stem scuffing in hot turbo charged engines employing sodium-filled hollow valves
- Advanced alloyed materials provide higher wear resistance required by side-loaded, heavy-duty engines using engine brake systems over thousands of operating hours

Turbocharger Bushings

- Self-lubricating materials aid best-in-class wear resistance in interaction with typical shaft materials
- Thermo-physical properties designed to allow component press-fitting, resulting in acceptable stresses in the housings at elevated temperatures
- Advanced powder metal alloys are resistant to oxidation and enable turbochargers to operate at exhaust gas temperatures up to 1050°C



Sealing





Federal-Mogul Powertrain delivers superior sealing and shielding solutions for vehicle, transportation, machinery and industrial markets worldwide. We are a leading designer of engine, transmission and driveline sealing systems. Our advanced engineering and analytical capabilities reduce development time, validate quality and improve performance.

MLS and Steel/Elastomer Cylinder Head Gaskets

- Comprehensive portfolio of cylinder head gasket sealing technologies that address application architecture challenges associated with emissions, friction and fuel economy/CO₂ reduction initiatives
- Laspot[®], BOSTEC[®] and INSTOP[®] Multi-layer Steel (MLS) technologies provide unique characteristics to address application challenges associated with engine structure, thermal and mechanical stresses and head-to-block joint dynamics
- Flexstop gasket technology enables improved cylinder head gasket performance related to plastic and elastic joint deformations, proven to reduce wear potential of the cylinder block due to gasket stopper loading and unloading
- Advanced steel elastomer cylinder head gasket technology for mid-range and heavy-duty diesel engines provides high reliability performance with 250 bar combustion sealing capability and low load-to-seal fluid sealing

Dynamic Seals

- 2015 PACE[™] Award winning MicroTorq[™] seal provides industry benchmark for low frictional torque and CO₂ reduction yet is capable of handling crankcase pressure and vacuum requirements of modern engines
- Flat-Install[®] heavy-duty engine seal with bonded polytetrafluoroethylene (PTFE) offers high value and durability for severe duty environments
- Seal design and material portfolio including unitized seals capable of low temperature performance and compatible in aggressive fluids

Bonded Pistons

- Lip optimized for installation robustness and increased durability
- Hysteresis of sealing lip reduced compared to alternative sealing technologies as measured on proprietary drag test
- 2013 PACE[™] Award winning injection molding of high modulus bonded pistons for automatic transmissions ensure higher quality and improved durability

High Temperature Exhaust System Gaskets

- Portfolio of technical solutions tailored to meet the increasing temperature requirements of hot gas application environments, exhaust manifold, turbocharger and EGR systems
- PACE[™] Award winning range of High Temperature Alloys (HTA) provide sealing solutions to meet increasing demand for exhaust and EGR systems at temperatures up to 1000°C
- Innovative High Temperature Coating (HTC) enhances sealing capability and is thermally stable up to 1000°C

Engineered Elastomeric Gaskets

- Comprehensive range of materials and solutions for specific fluid and temperature environments
- Industry-leading analytical tools enable rapid development of sealing solutions and functionality that is "right the first time"
- New DOTG free AEM material with excellent acid resistance for combustion by-products

Heat Shields

- Complete product offering provides shielding and thermal management technology solutions to meet powertrain system demands related to high heat, reduced weight and noise reduction
- Ultra low-weight aluminum based Nimbus[®] GII technology provides up to 80% mass reduction and supports fuel savings and CO₂ emissions reduction initiatives
- Acoutherm[®] Light technology meets OEM sound absorption requirements, and occupant comfort demands
- Al-Re aluminum reinforced technology targets increased thermal effectiveness and mass reduction in high surface temp/turbo-boosted engine applications

Ignition





In every internal combustion engine, ignition is the process that releases the power stored in the fuel. We are a market leader in the development of innovative, premium-quality ignition products. Federal-Mogul Powertrain engineers develop ignition technologies as one integrated system, adapting to modern advances in engine design that demand more of ignition components than ever before.

Spark Plugs

- Best-in-class SureFire and SureFire Plus ceramic technology with standard 96% and high performance 99% Al_2O_3 ceramics, enable high energy and smaller plug designs to facilitate engine downsizing and high-end direct injected turbocharged engines
- Strong in-house development of platinum and iridium-alloy electrodes for most severe combustion conditions

Ignition Coils

- Ignition coils configured in pencil and plug top, multi-outlet, individual or multi-coil rail geometries

Advanced Corona Ignition System (ACIS)

- Break-through technology uses a high-energy, high frequency electrical field to produce repeatable, controlled ionization, creating multiple streams of ions to ignite the fuel mixture in the combustion chamber
- Facilitates advanced combustion strategies like lean burn, highly diluted mixtures and very high exhaust gas recirculation enabling fuel efficiency improvements up to 10% over standard spark ignition systems
- ACIS system technology enables up to 10% reduced fuel consumption and is designed for volume manufacturing in current and future engine architectures
- Fully developed for light vehicle petroleum and industrial gas engines

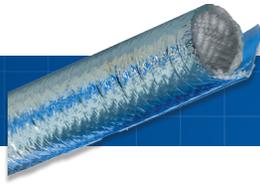
Industrial Plugs

- Premium, Value, and Standard product classes supporting global application requirements, BMEP loads, combustion behaviors, gas types and duty cycles
- Highly innovative premium product line-up exclusive to Federal-Mogul Powertrain is tailored to high BMEP/power output applications. Products offer up to 5x the service life capability compared to standard J-gap spark plugs due to state-of-the-art component and electrode technologies with optimized thermal paths, maximized electrode surface areas and significantly reduced wear rates
- Extensive standard and value M18 product portfolio, servicing new and legacy applications, gives two preferred service life and robustness vs. cost options
- Optimized pre-chamber spark plug product line for lean burn. Highly efficient Open Chamber applications offer central ignition point for improved mass fraction burn rate, ignitability and service life. Iridium and Platinum electrode options available with more than 20mm² of spark surface area



Systems Protection





Federal-Mogul Powertrain's systems protection products provide innovative solutions to our automotive, heavy-duty, energy, industrial and aerospace customers.

Our global network of testing labs and engineering support services are unsurpassed. We utilize standard SAE and ASTM testing methods alongside customized tests to diagnose problems, confirm core resolutions and develop custom solutions.

Abrasion

- Superior abrasion protection in easy-to-apply, flexible designs including expandable, self-wrapping and flat profile. Ideal for instrument panel and engine harnesses; tubing, hose and cable assemblies
- TwistTube® wrappable and FlexGuard® tubular sleeves provide flexible component protection alternatives for operating temperatures up to 200° C

Thermal Management

- Innovative designs expand for flanges and bends with unique material combinations and self-sealing features
- Convective and radiant heat solutions for EGR tubes and exhaust systems, fuel and hydraulic lines, battery and control cables, wire harnesses, hoses and tubing
- ThermFlex® insulator is a lightweight thermal management sleeving that enables increased vehicle emissions performance and withstands excessive exhaust temperatures
- Thermal reflective products like ReflexWrap®, ReflectSleeve® and ReflectShield® are ideally suited for smaller confined spaces and shield components by reflecting radiant heat energy

Electromagnetic Interference (EMI) Shielding

- Lightweight, durable and easy-to-install products reduce electromagnetic interference in vehicles
- Specially designed yarn and wire technology combine for exceptional performance
- Addresses growing concerns for engine and instrument panel harnesses, power and battery cables, and starter assemblies

Noise, Vibration and Harshness

- Engineered to address NVH in interior door panels, headliners, HVAC systems, cables, hoses and tubing
- Innovative material combinations to meet application conditions including eco-friendly alternatives with outstanding noise suppression and absorption properties

Safety

- CrushShield® durable textile sleeving absorbs and disperses energy, preventing damage to electrical cables and offering cut-through protection for fuel lines, electrical harnesses and other critical components for hybrid and electric vehicles during crash situations

The Heartbeat of Powertrains, Big and Small.

The combustion engine is the heart of the powertrain. At Federal-Mogul Powertrain, we pride ourselves in creating highly-engineered solutions for the toughest applications – to improve fuel economy, reduce emissions and enhance durability. Our innovative technologies enable reduced friction, supporting engine downsizing, higher compression ratios and improved performance. We produce components for the smallest engines with 25mm bore size up to the world's largest engines with 980mm bores and 100,000 hp. Our products are manufactured at single-digit tolerances and engineered to withstand the toughest conditions in today's highly loaded engines. Whether it is pistons; rings; cylinder liners; sealings, hot and cold gaskets; bearings; ignition; engine valves; or systems protection components we are the heartbeat of combustion engines – big and small.

Find out how Federal-Mogul Powertrain's technologies are built to keep your engine's heartbeat running at peak performance. Visit www.federalmogul.com for details.



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