Metaloflex® Metal Layer Cylinder-Head Gaskets.
The Future is in the Head.

elring klinger
Cover modules
The bundled quality of complete pre-assembled units for the engine and transmission – with complete sealing and fastening systems as well as accessories.

Cylinder-head gaskets
The key components when it comes to sealing car and truck engines. The right technology for any engine design. Innovative, environmentally friendly, powerful and cost-effective.

Specialty gaskets
Flexible sealing systems for the most diverse of applications in the engine, transmission, exhaust system and auxiliary components. Available in a wide variety of material and design combinations.

Shielding systems
Efficient heat management based on comprehensive thermal protection. Higher ride comfort and enhanced environmental protection based on acoustic shielding. Usable throughout the vehicle, including on the engine and the underbody.

Experience Mobility: The ElringKlinger Group.

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Transmission applications
Expertise and reliability all from one source: gaskets, cover modules and shielding systems specially designed for transmissions. As well as bearing, piston and guide rings made of PTFE or PEEK.

ElringKlinger plastic technology
Customized gaskets and design elements made of high-performance plastics for the automotive industry, medical engineering and other industrial sectors.

ElringKlinger engine technology
Simulating the extreme conditions. With state-of-the-art test benches for putting complete engines and individual components to the test. Rapid, informative results for shorter development lead times.

Original Elring parts
Gaskets, sealing sets and service parts in top quality for professional servicing. Safe and reliable. Available in over 140 countries.
Metaloflex® Cylinder-Head Gaskets. Solutions are Born in the Head.

In modern engines, Metaloflex® cylinder-head gaskets have a firm position worldwide. As key components, they contribute to efficient, reliable and economical engine operation.

The cylinder-head gasket assures a reliable seal between the cylinder head and block for combustion gases, engine oil and coolant. It also acts as a load transmitting element between the cylinder head and the crankcase, and as such has considerable influence on the distribution of forces and cylinder distortions and the resulting component deformations within the engine.

Maximum freedom of design
Metaloflex® from ElringKlinger: the internationally recognized brand name for innovative metal layer cylinder-head gaskets of embossed, elastomer-coated spring steel layers – single-layer or multi-layer, depending on the application. Thanks to the modular design with the coating, bead and stopper functional components, this sealing system can be matched individually and precisely to the special requirements of the engine. And this saves time-consuming and costly iterative steps in development and trials. For maximum freedom of scope in engine design.

The technical strength of the metal layer cylinder-head gasket is especially apparent in diesel engines and high-performance gasoline engines with direct injection. Introduced to the market at the beginning of the 90s by ElringKlinger, today this sealing system is the unchallenged international number one in the automotive area. With Metaloflex®, ElringKlinger is the world's largest manufacturer of metal layer cylinder-head gaskets.

The next generation: coined stoppers
With the newly developed coined meander and honey comb stoppers, which can also be designed to include a height profile (topography), still more economical solutions can be achieved with the same functional potential. Innovative stamping technologies enable practically any geometrical profiling, with regard to both stopper width and stopper thickness. Thus, by way of the classical stopper surface, the technical designer can now also implement additional supporting elements nearly anywhere on the gasket – additional functions for greater variations and flexibility in design.
Engineering.
The Challenge of the Future.

Mastering extreme loads, constantly extending the boundaries of what is feasible. We develop creative product solutions for the engine generations of today and tomorrow. And we never lose sight of the overall engine system and the interaction of all engine components. Every cylinder-head gasket is precision engineered: according to the specifications drawn up in close cooperation with our customers – implemented with the most modern development and trial tools, with the goal of further optimizing development times and costs. Engineering services throughout the world – from ElringKlinger.

The finite element method – optimizing up to the ideal solution.

The finite element method (FEM) is the decisive tool for the analytical investigation of the sealing system. The FE method is used on the one hand to optimize the bead and stopper functional components in the gasket, including their manufacture, and on the other hand to analyze the structure of the entire sealing system in the engine. The following examples illustrate how the optimal sealing concept is developed to meet special requirements.

Determination of the ideal stopper topography for increasing sealing potential

Topographical stoppers, i.e. stoppers with variable thickness, can be used to compensate for inconsistent component rigidities. This prestresses less rigid areas, so that the compressive load becomes uniform. For the design of the topography, all parameters must be considered: besides the rigidity of the adjacent engine components, such as the cylinder head and the engine block, the different operating states of the engine are critical. This means taking into account the prestressing of the bolts, the temperature distribution and, above all, the gas pressure to be reliably sealed.
Every engine operating state is associated with a specific topography, enabling uniform compressive distribution on the stopper and thus a reliable sealing function. With the FEM, the ideal stopper topography in relation to all operating states is then determined and reliable functioning guaranteed even under critical conditions.

The FE calculation of the ideal stopper topography considers such parameters as the rigidity of the adjacent components, ignition force and prestressing of the bolts.

Cylinder-head gasket with additional function: supporting elements for reducing component deformations

The new ElringKlinger stamping technology enables the integration of additional supporting elements beyond the scope of the classic stopper area nearly anywhere on the cylinder-head gasket, for example, on the front of the engine to reduce flexing of the cylinder head. Normally, the deformation is most pronounced with the end cylinders, since the greatest bolt force relative to the cylinder segment is introduced here. The cylinder head lies on the supporting elements of the cylinder-head gasket, preventing excessive flexing. The FEM-based selective height matching of the supporting elements reduces the cylinder head deformation to a minimum. This substantially reduces the distortion of the camshaft bearing gutter and thus also reduces noise emission.
Deformation of the cylinder-head without supporting elements.

Flexing of the cylinder head as a function of supporting element thickness.

Support elements for the reduction of component stresses

Another important task of the supporting elements integrated in the cylinder-head gasket is to reduce stresses in the components. Supporting characteristics calculated exactly by the FEM can reduce critical stresses to a manageable level.
**Topographical double stopper for reducing cylinder distortion**

The cylinder distortion in the stressed sealing system determines the oil consumption of the engine.

Among the difficulties associated with sealing the oil are the higher order cylinder form deviations, because the piston rings are not able to follow the cylinder barrel as well. The degree of this distortion depends primarily on the geometrical structure and rigidity of the components and can be considerably influenced by the cylinder-head gasket. By using a double stopper instead of a standard stopper, cylinder distortion can be reduced by as much as 25%, depending on the engine design. Further optimization using an additional topographical stopper results in a reduction of more than 50% in distortion.

![Influence of cylinder-head gasket on cylinder distortion.](image)

**Simulation – testing under realistic conditions.**

Complementing the FEM structural analysis, the durability of the sealing system is ensured by simulation.

**Servo-hydraulic testing**

This station is used to preselect and test the gasket design. The sealing surfaces of cylinders are simulated with flanges to verify the combustion chamber design of the cylinder-head gasket. The goal is to determine the maximum permissible amplitude of vibration for the required fatigue strength. Also, the minimum compressive force necessary for sealing is calculated with pressure tests. These tests yield important information about the bead design.

![Testing the cylinder-head gasket bead durability on a servo-hydraulic test station.](image)
**Dynamic internal pressure simulation**

The results of the tests on the servo-hydraulic test station serve as the basis for testing the entire sealing system under realistic conditions by simulating the internal pressure dynamically. This functional test is performed on original engine parts (head, block, cylinder-head gasket) with the actual ignition sequence and with various temperature cycles. The correlation between the component rigidity, the dynamic vibrations occurring in the sealing gap and the tensioning system provide crucial data about the sealing system as a whole.

The dynamic internal pressure simulation considerably reduces the number of engine tests, saving both time and money, so that in the future development times will be even shorter.

**Simulation of wear mechanisms on the engine**

Due to increasing peak pressures, the relative movements occurring in the sealing gap and the resulting wear behaviour must be considered even in the cylinder-head gasket design calculation.

With the wear testing station, ElringKlinger has a versatile tool for simulating wear mechanisms on the engine. The goal is to determine the permissible range of values for the coefficient of friction in the sealing gap. This requires parameter studies under realistic engine operating conditions. Taking into account the compressive and force relationships from the FE calculation, it is then possible to determine suitable designs and coatings for the prevention of wear in the development phase.
**Design.**
**Gasket Know-How, Layer for Layer.**

The optimal interaction of the individual structural elements of Metalo-flex® metal layer cylinder-head gaskets guarantees the functioning and reliability of the sealing system.

*Half beads*
The half beads generate a two-line compression. They seal along the coolant and engine oil passages, around the bolt holes and the circumference of the outer sealing contour.

*Full beads*
The full beads generate three-line compression around the circumference of the combustion chamber. This elastic sealing element enables the sealing of very high ignition pressures, even in the presence of large dynamic sealing gap oscillations.

*Functional layers*
These elastomer-coated spring steel layers are equipped with elastic beads.

*Carrier layers*
The main function of the carrier layer is to match the gasket thickness to the installation conditions required by the design.

*Stoppers*
The engine components are elastically prestressed by the stoppers around the circumference of the combustion chamber. This reduces the sealing gap oscillations resulting from the gas force and at the same time prevents an unacceptable deformation of the full beads. The successors to doubled and laser-welded stoppers, today’s coined stoppers (in the figure: honey comb design) represent the newest generation.
For design engineers, the new stamping technologies from ElringKlinger open up many possibilities for influencing the distribution of forces in the sealing gap. Metaloflex® cylinder-head gaskets with coined meander or honey comb stoppers offer other decisive advantages besides being highly cost-effective.

**Expertise from the very beginning.**

The development of the cylinder-head gasket has been characterized over the last 10 years essentially by the adaptation of the metal layer technology to the constantly increasing and highly diverse demands of modern high-performance engines. ElringKlinger, as the leader in this technology, has repeatedly set new standards and further extended the limits of what is possible. With innovative sealing and production methods, we achieve even more economical solutions with the same functional potential. The development of the entirely new coined stopper is just one such milestone.

**Still more design flexibility through supporting elements**

After Metaloflex® cylinder-head gaskets were first equipped with folded stopper layers, from the middle of the 90s ElringKlinger very successfully introduced laser-welded stoppers in series production. In the meantime, the coined stopper represents the next generation. The goal of its development was to be able to manufacture the ideal stopper version with suitable stamping technology for every Metaloflex® design. A fundamental distinction is made between stopper stampings in spring steel layers (meander) and in carrier layers (honey comb). The manufacturing procedures for meander and honey comb stoppers permit nearly any geometrical profiling, with regard to both stopper width and stopper thickness. By way of the classical stopper surface, the design engineer can now also implement additional supporting elements nearly anywhere on the gasket.
The first Metaloflex® generation: folded stopper layers.

With carrier layer.

Without carrier layer.

The second Metaloflex® generation: laser-welded stoppers.

With carrier layer.

Without carrier layer.

The new Metaloflex® generation: coined stoppers.

Honey comb stopper in carrier layer.

Meander stopper in functional layer.
Meander stoppers in spring steel layers.

With the meander stopper, the geometrical stopper surface defined by the engine is exploited to the full. A meander “micro bead” produces a thickening which can replace the earlier laser-welded stopper, with almost exactly the same rigidity. The reason: the large number of windings due to the meander geometry increase the rigidity of the stopper, preventing flexing and undesirable elasticity at engine operation, since such an elastic stopper would cause more vertical motion in the sealing gap under ignition pressure in the engine and so compromise the durability of the system.

Comparison of a rigid stopper with an elastic stopper for relief through ignition pressure. Under the same conditions, the elastic stopper causes vibrations with more than double the amplitude in the sealing gap.
Honey comb stoppers in carrier layers.

To compensate for engine production tolerances, different installation thicknesses, achieved via variable carrier layer thicknesses, are generally used in diesel engines. This has the advantage that the behaviour of the gasket is not affected by the different layer thicknesses.

The stopper pattern in the carrier plate is in honey comb geometry. The rigidity of these stoppers is comparable with that of welded stoppers. The stamping process developed by ElringKlinger enables the both planar and topographical stoppers to be manufactured with a high degree of precision.

Topographically coined stoppers.

The stopper design consciously influences the compressive distribution and thus also the oscillation of the sealing gap, since they cause an increase in the compressive force and elastic prestressing of the entire sealing system. With non-uniform rigidity of the adjoining engine components, a thickness profiling of the stopper may be necessary. Here, coined stoppers offer important functional advantages: nearly every required topographical form can be implemented for the engine components. The height profiling can be variably defined, both for each cylinder and also for other areas on the gasket.

The topographical stopper allows compensation for inconsistent component rigidities. Areas with low rigidities can be prestressed, giving a uniform compressive load. In this way, the available bolt force can be exactly distributed and optimally utilized over the required areas.
**Partial Coating – Less is More.**

Due to the partial elastomer coating, adapted to the required function, only the surface areas of the cylinder-head gasket relevant for sealing are coated. As a result, the surfaces standing free in coolant or oil can remain uncoated, so that coatings no longer peel under critical marginal conditions. Other advantages of this method: Due to the special procedure for applying the coating, both the coating thickness and the coating medium are selected according to the application. The somewhat differing coating requirements in the combustion chamber and in the fluid area can then be fulfilled selectively. Thus, for significant component roughness or pores in the coolant and oil seal, greater layer thickness and a softer elastomer are advantageous. At the same time, lower layer thicknesses are required for sealing the ignition pressure in the combustion chamber area. These goal conflicts are resolved with the use of selective coating.

Example: newly developed coatings with optimized frictional behaviour prevent the wear of components when the engine is running. The outstanding adaptability, which already exists at room temperature, provides the basis for mastering the requirements in the cold leak test immediately following installation.
Designs – Customized for Best Performance.

No two engines are identical. In the same way, no two gaskets are. The requirement: a variable sealing system which can be matched exactly to the respective engine performance specifications. With Metaloflex® Elring-Klinger has the right engineering answer.

*Coined stopper: the stopper generation of the future – with even greater functional potential*

*Laser-welded stopper: the proven solution – has been in series production for many years*

*Single-layer, 0.30 – 0.37 mm: design for gasoline engines.*

*Two-layer, 0.50 – 0.65 mm: two functional layers. Design for gasoline engines and diesel engines subjected to high stresses, without installation thickness matching. High sealing potential for the smallest installation thicknesses.*

*Three-layer, from 0.70 mm: two functional layers, one carrier layer. Design for diesel and gasoline engines with installation thicknesses greater than 0.70 mm.*

*Four-layer, from 0.90 mm: with additional cover layer to compensate for surface imperfections on components (porosity, cavities).*

*These designs can also be equipped with topographical stoppers.*
Depending on the respective parameters, the areas of application for the different cylinder-head gasket designs overlap for each engine with respect to the optimal technology and also cost effectiveness. With Meta-loflex®, ElringKlinger offers a versatile, modern sealing system allowing the development of the most effective and most economical solution for all applications.
Design Solutions for Special Applications – Adaptation is Everything.

High-performance engines require high-performance gaskets. The outstanding design flexibility of Metaloflex® allows optimally matched product solutions for the respective engine conditions, even with extreme requirements.

Metaloflex® as a multifunctional layer gasket with large sealing gap vibration amplitudes.

If the sealing gap oscillations have a large amplitude, Metaloflex® is used with three or four functional layers. This allows sealing over a larger spring travel. ElringKlinger tunes the systems so that the entire spring travel is always uniformly distributed over the beads. In connection with coined stops, multifunctional layer gaskets with topographical stops can also be manufactured. With this gasket design, durability is guaranteed even under very critical dynamic conditions.
Metaloflex® cylinder-head gaskets with double stopper for reciprocating engines offer a high degree of lifetime reliability.

For engines with pressed-in or cast cylinder sleeves, ElringKlinger has developed a Metaloflex® cylinder head gasket with double stopper system. The required prestressing force is distributed over two stoppers, thus preventing the danger of the liner sinking. This ensures lifetime reliability, even under critical conditions. Here, coined stoppers – meander and honey comb – offer exceptional possibilities for adapting to the engine operating conditions, for example with the use of different stopper heights in combination with a height profile.

Metaloflex® cylinder head gasket without stopper for substantially reducing cylinder deformation.

This Metaloflex® design eliminates the stopper and therefore combustion chamber camber at high compression. It consists of two function layers with opposingly arranged beads in the main seal. A complex design is required to guarantee the durability of the beads: bead deformation is no longer determined by the stopper, but only by the operating range in the engine and the dynamic sealing gap movements. ElringKlinger is the first supplier in Europe to offer a series version of the stopper-free cylinder-head gasket.
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