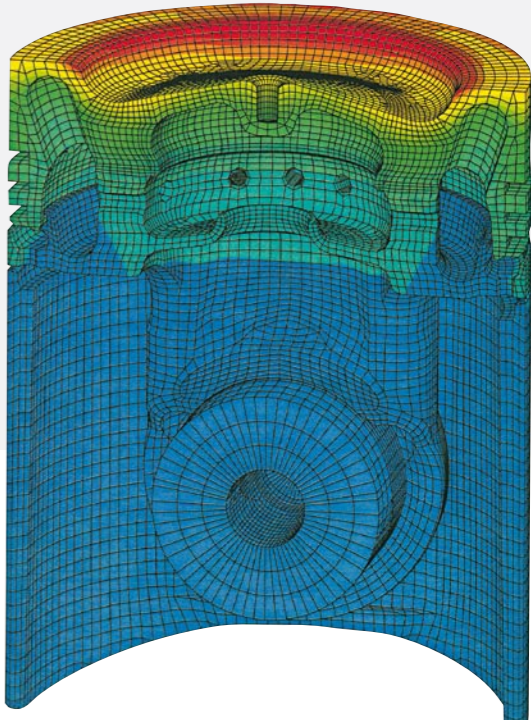
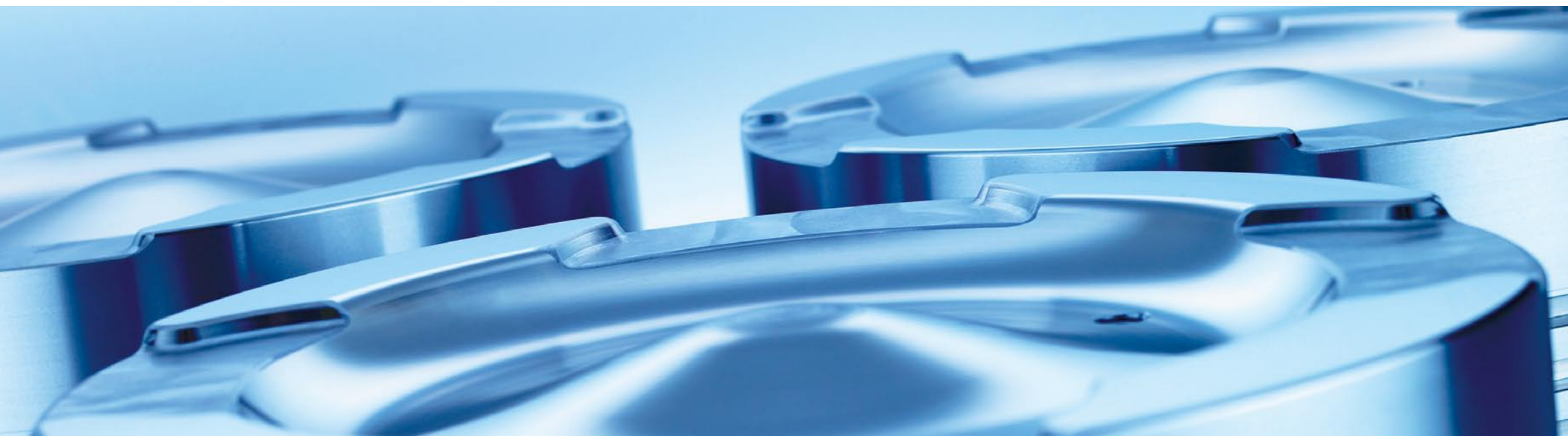


KOLBENSCHMIDT PIERBURG GROUP



LARGE BORE PISTONS



KS KOLBENSCHMIDT GMBH

PARTNER OF THE MOTOR VEHICLE AND ENGINE INDUSTRY

KS Kolbenschmidt GmbH develops, produces and sells pistons for combustion engines (for passenger cars, commercial vehicles, ships, stationary engines) as well as for piston compressors.

Thanks to a global network of production and sales units stretching from Shanghai to São Paulo, we're never far from our customers, assuring fast, flexible service and support. At nine strategically sited locations, KS Kolbenschmidt's 5,480-strong workforce develops, produces and distributes engine pistons and reciprocating compressors in Europe, North America, South America and Asia. We have long since counted the world's major engine manufacturers among our core customers, all of whom come to us with highest expectations of quality.

KS Kolbenschmidt with its range of products extends from pistons for professional chainsaws and heavy-duty machinery through to applications for passenger vehicles, trucks, ships, locomotives and stationary equipment. Moreover, we

cover the entire diameter spectrum from 20 to 640 mm. Our pistons, made of aluminum, spheroidal graphite iron or steel, as well as combinations of these materials, enable us to meet the complete range of performance requirements levied by our customers.

KS Kolbenschmidt is doing its utmost to achieve the goal of ever reduced fuel consumption, reduced emission of pollutants and ever-lower weight, making us the natural source for advanced piston systems when it comes to direct injection gasoline engines, high-performance diesel and lightweight applications or modules.

Whether for innovative piston designs and the latest layout calculations, optimised production calculations or the just-in-time delivery of high-precision pistons – KS Kolbenschmidt customers worldwide appreciate our fast service and stringent standards of quality.

Research and Development

Product development at KS Kolbenschmidt ranges from basic research, material and technology development to the adaptation of these basic developments to the customers individual requirements.

Large bore pistons, due to the high cost of actual testing in an engine, demand and place special priority to the design concept. Modern analytical methods and systems are employed, e.g. CAD (2D and 3D), 3D finite element analysis and high-speed photography in shaker test investigations.

R&D Highlights Large Pistons

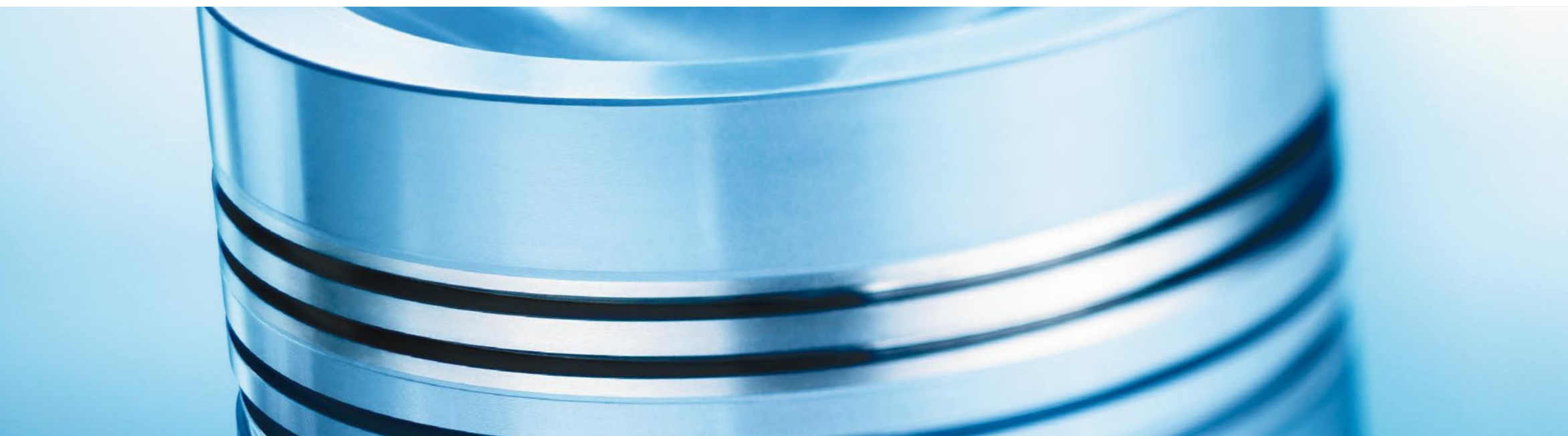
- 3-piece Articulated Pistons
- Steel Skirts for Composite Pistons
- Steel Monobloc Pistons
- Fibre-reinforced Aluminum Pistons
- Low-friction Pistons

Production Engineering The Corner-stone to Success

Machining of pistons at KS Kolbenschmidt is done using state-of-the-art NC and CNC equipment. This ensures a maximum of machining accuracy, production reliability, reproducibility and economic efficiency.

Quality Our Biggest Asset

The high quality standards maintained by KS Kolbenschmidt's large bore pistons is ensured by in-production quality systems and final inspections employing sophisticated inspection equipment as the 3-coordinate measurement units, isotope-, X-ray-equipment, ultrasonic testing equipment for non-destructive testing.



ALUMINUM PISTONS

One piece aluminum pistons made of KS 1275 eutectic AlSi alloy, are employed in diameters ranging from 160 to approximately 450 mm. Pistons with diameters exceeding 200 mm are manufactured employing directionally chilled fine grain castings, with cast-in ring carriers of austenitic grey iron and cooling coils.

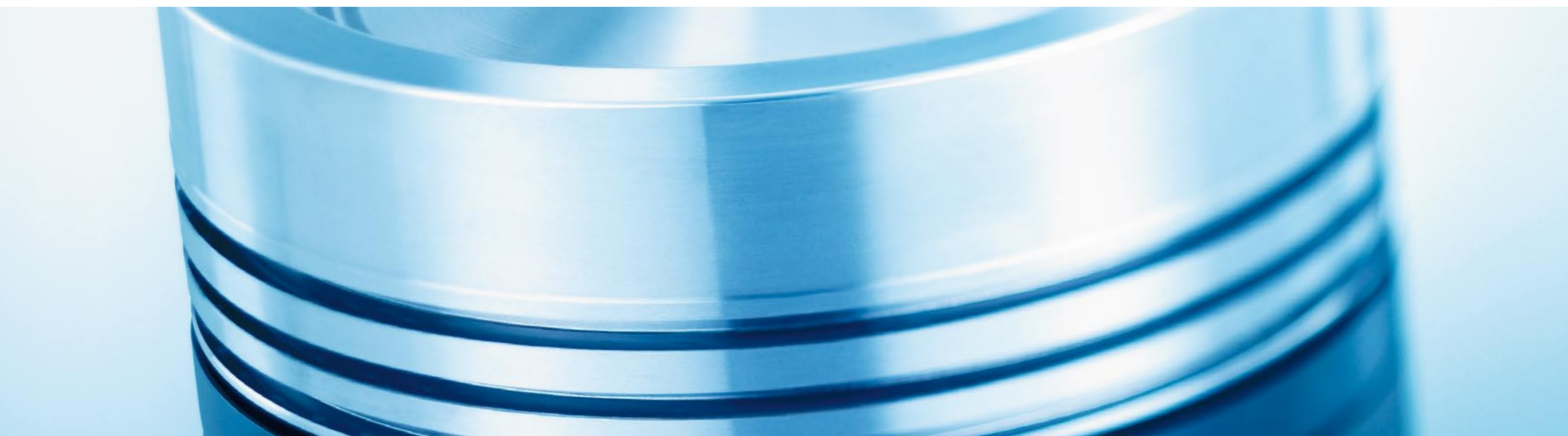
Aluminum pistons in the 160 to 200 mm diameter range are either of one-piece permanent mold castings, in some cases with either casting saltcore cooling gallery and single or double ring carrier, or electron-beam-welded pistons where a forged skirt is welded to an aluminum casting containing the salt core cooling gallery and the ring carrier by means of electron beam welding.



ALUMINUM PISTONS WITH FIBRE REINFORCEMENT

Electron-beam-welded pistons are usually made out of a lower part (skirt), which is forged and an upper part which is cast and has a single or a double ring carrier and if necessary it has a cooling gallery. The material is the well known KS 1275 alloy. If there is a special request from an engine builder for the design of the combustion bowl like a reentrant design, KS Kolbenschmidt can implement a fibre reinforced bowl rim. This fibre reinforced ring is squeeze cast under high pressure. The fibre body itself consists of 20% Al₂O₃ fibres and gives together with the squeeze cast aluminum a high strength for the high loaded bowl rim area. The fibre reinforced ring is connected to the upper part of the pistons by electron beam welding too.





NCI MONOBLOC PISTONS



Monobloc pistons made of GGG 70 were introduced to the market by KS Kolbenschmidt in 1973. Since this time they have undergone constant development. High strength and low thermal expansion of the material used allow the manufacturing of thin-wall pistons and the introduction of low running clearances. Monobloc pistons in diameters from 170 to 350 mm diameters

represent an economically attractive alternative to composite pistons in account of their simple design (no connecting elements, integrated cooling spaces) and their proven reliability with heavy fuel operation.



ARTICULATED PISTONS

The KS Kolbenschmidt design for an articulated large bore piston is a three piece articulated piston or a composite articulated piston. The forged steel crown (material: 42 CrMo 4V) is bolted together with a cast pin boss (material: GGG 70). The skirt is made out of forged aluminum (KS 1275) and it is connected to the pin boss by the piston pin. The advantages of this design are basically the low weight by achieving high performance data and it is possible to achieve a relatively low compression height.





COMPOSITE PISTONS WITH ALUMINUM-SKIRT



Composite pistons with a forged crown made of 42 CrMo 4 steel and a forged aluminum skirt made of KS 1275 were developed in the 1960's with the objective of separating thermal and mechanical loads by employing the ideal materials for the crown and the skirt respectively, with further advantages such as unlimited heavy fuel suitability and repair feasibility. This design has established itself over the entire diameter range,

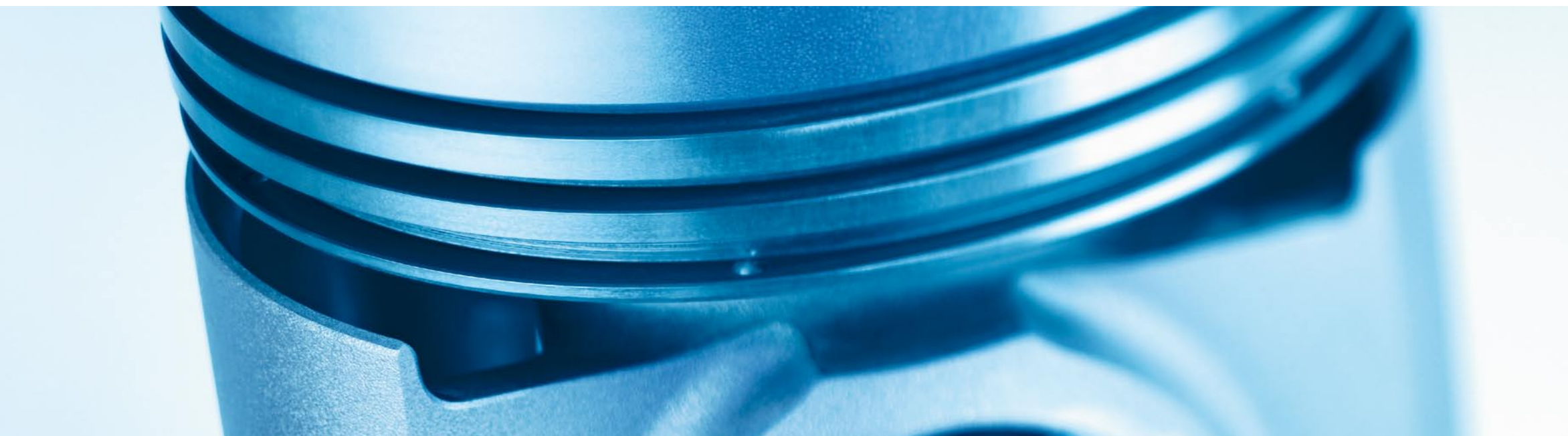
i.e. from 160 to 620 mm, and is up to now the standard piston type in medium speed engines. Future developments, however, require different designs and consequently St/Al pistons will decrease due to their limitation in peak firing pressure.



COMPOSITE PISTONS WITH NCI-SKIRT

Composite pistons with a conventional designed steel crown section and NCI-skirts are used wherever the peak firing pressure exceeds the limits of aluminum skirts, i.e. pressures of approx. 18.0 to 21.0 MPa. Composite pistons have been developed by KS Kolbenschmidt GmbH for even higher firing pressures, which utilize a bore-cooled, rigid steel crown and a correspondingly dimensioned NCI 70-skirt.





COMPOSITE PISTONS WITH STEEL-SKIRT

For future developments and for some special applications today KS Kolbenschmidt is using a composite piston with a steel skirt. The crown and the skirt are made out of forged steel (42 CrMo 4V). This design can then be used for very high peak firing pressures in the range of 21 to 25 MPa. The advantage of this design is the relatively low weight in comparison to NCI due to the fact, that you can use a reduced wall thickness. The low weight steel skirt and the forged steel crown (standard or bore cooled) are bolted together. The high strength of the skirt material gives some space for even higher peak firing pressures and further developments of this piston type.



STEEL MONOBLOC PISTONS

The steel monobloc piston (material: 42 CrMo 4V) is today mainly used in the diameter range of 160 to 210 mm. This design combines the advantages of a monobloc piston with the advantages of forged steel for the whole piston. The forged steel crown and the forged steel skirt are connected by electron beam welding or friction welding. This means you can reduce the piston height to an absolute minimum figure (compression height). The steel monobloc with a closed cooling gallery is prepared for high thermal and mechanical load with relatively low weight.



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